TREES and SHRUBS

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TREES and SHRUBS
Yellowstone National Park

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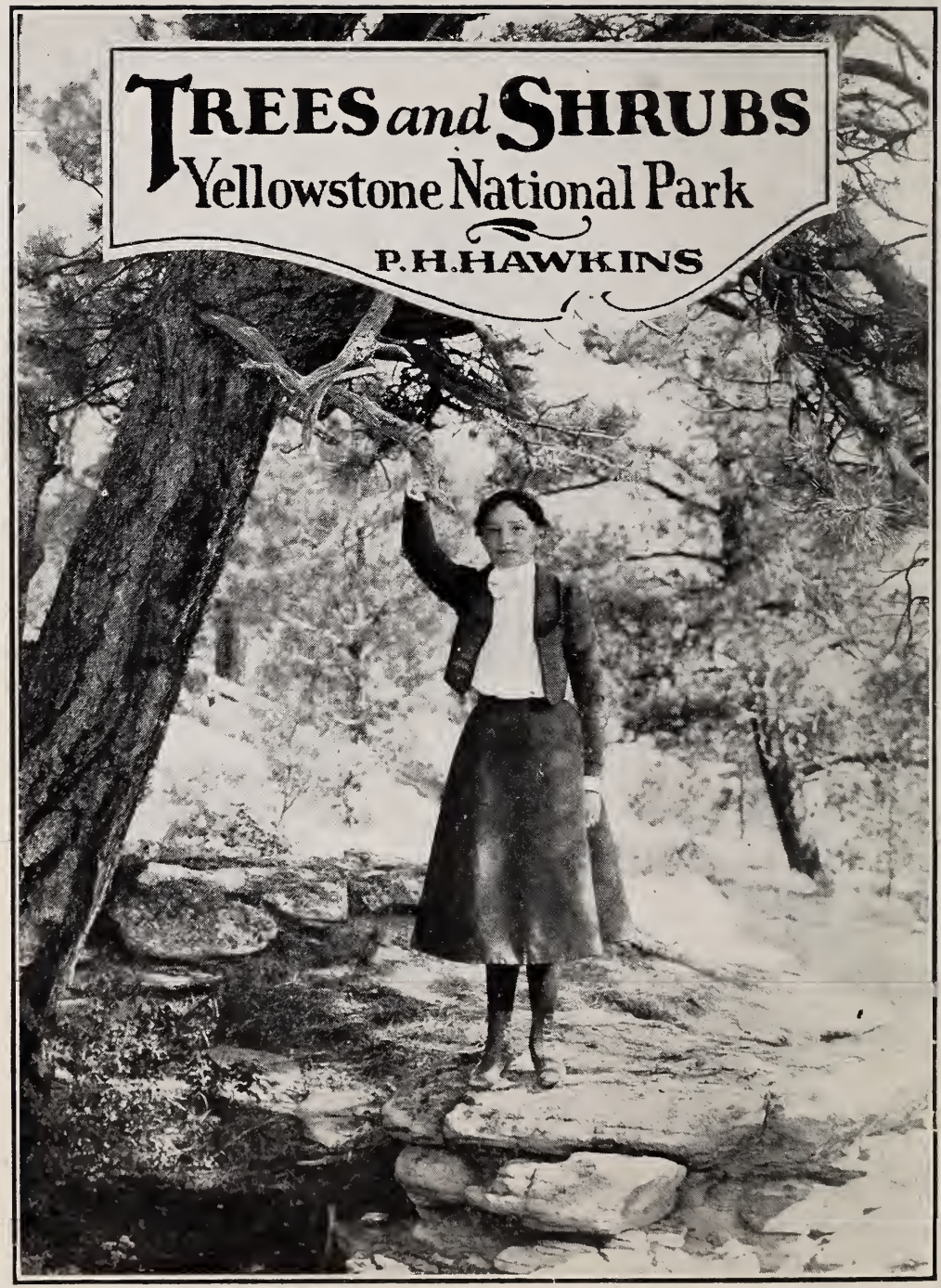

THE
TREES and SHRUBS
OF
YELLOWSTONE NATIONAL PARK

By

PLINY HAINE HAWKINS, M.S.

A scientific and popular description of
all the trees and shrubs
with special reference to their economic use
and their relations to
wild life.

1924

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The Trees and Shrubs of Yellowstone Park

SCIENTIFIC books, vivid descriptions, and beautiful pictures may attract the attention or refresh the memory, but they are not a substitute for personal acquaintance with trees. The joy of knowing them in calm and in storm, in summer sunshine and in delicate tracery against the winter sky, comes to him who meets them personally. Trees are not mere objects, they are alive. They have youth, fruition and old age. They struggle with the forces of nature, as we do, and play a most significant part in our lives and in the lives of the associated plants and animals.

The forest is a wonderful comrade. How alluring it is to tread alone that noiseless carpet of pine under the double canopy of leaves and sky. Paths wind among lichen-covered boles, no one knows where. In the soft earth are footprints of animals we have never seen and whose existence we have not even suspected. Then there is the fragrance of fern, flower, and shrub. Wild fruits hold out tempting branches. The sun makes marvelous patterns on the forest floor. Rocks and trees tell interesting stories if we are intelligent enough to read them. Not only do they please the senses, the mind responds to their healing balm and our cares and troubles are forgotten.

"For his gayer hours she has a voice of gladness, and a smile
And eloquence of beauty: and she glides
Into his darker musings with a mild
And healing sympathy, that steals away
Their sharpness, ere he is aware."

Here in this highest and coolest of our national playgrounds, we may well spend a few days in the forest.

Nature takes us as deep into her mysteries as we are able to go. Those with delicate sympathies will rejoice with the birds that their table is so bountifully spread with buds and berries. They will open their hearts to the simpler life of the flowers whose being is so wondrously fair. The artist will see the world anew with shifting cloud or rising wind.

In Nature's domain, we advance according to our ability to observe and think and love. Man, among the trees, is no longer the tyrant of the universe, but one of Mother Nature's children. The trained, thoughtful, considerate mind goes on and on, the forest becoming his sacred shrine. He does nothing to mar its beauty. Camp refuse is burned or buried. The spring remains unpolluted. The camp fire is completely extinguished. Only the clean ashes of his fire, made on some stony point where it cannot spread, mark his visit to the temple he loves and reveres.

LIFE ZONES

In ascending the Rocky Mountains, the temperature falls one degree Fahr. for each two hundred fifty feet of elevation, making five life zones in Yellowstone National Park.

The Arctic Zone lies above ten thousand feet on the south side of the mountain. On the north side, it is five hundred feet lower. Generally speaking, it is at timberline. The plants and animals of the Arctic Zone are not stunted forms of lowland life, they are distinct species which perish if removed from their mountain haunts. In the southern Rockies, timberline rises to twelve thousand feet. Traveling northward it descends, till in Labrador and Greenland we find it at sea level. One half of the alpine plants of Yellowstone Park are also found in arctic North America. Hence, the trip from Roosevelt Camp to Grasshopper Glacier resembles a journey toward the North Pole.

The summit of Mt. Washburn is in the Arctic Zone, but the area is so small that it does not give an adequate conception of it. The trip into the higher Beartooth Mountains is one of the interesting features of the Park. While geo-

Courtesy of James C. Witham

THE ALPINE OR ARCTIC ZONE, AUGUST
Looking West in the Grasshopper Glacier Country

graphically they are not included, from a biological standpoint we must consider them a part of the Park. It is to be hoped that the boundaries will be extended to contain them. Granite Peak which lies a few miles east of Grasshopper Glacier, reaches an altitude of 12,985 feet and is the highest mountain in Montana. It has been ascended but once and will tax the resources of the most experienced mountain men. Showers of rock and avalanches of stone and snow, combined with fierce wind, make the ascent most hazardous. Morning is the best time to make the ascent for the rock fragments are then frozen and the air is quiet. Occasionally, in these mountain peaks, one encounters a wind which penetrates the clothing like ice water and saps the vitality in a few moments. Blasts of sharp stone cut the face like glass. Bruised, breathless, bleeding, one rolls behind the nearest rock to wait for a lull in which to beat a retreat. But these storms are very unusual. The mornings are commonly frosty and fair. By ten o'clock the films of ice on ponds is thawing. The wind usually rises about one o'clock P. M. Snow squalls are common in the middle of the afternoon, after which there is fine weather.

While the alpine zone is bleak, it is full of interest and beauty. The air is wonderfully crisp and clear. Journeys that seemingly may be accomplished in an hour take the entire day. Every depression contains a lakelet with crystal-clear ice water. Every foot of soil not covered with snow is a garden of wildflowers. The clouds pass below, about, and above in the most neighborly way. There is as much animal life as the vegetation can support. Deep down in great rock slides, the stonechats are twittering to their young as contentedly as robins. On bare rocks, the arctic sparrow sings his song and rears his young.

The base of the Arctic Zone at timberline has a mean annual temperature of 25° Fahr. and a rainfal of 45 inches. While this is slightly more than that of the lower zones, the available moisture for plant growth is much less owing to the high winds and rapid evaporation. Flowers and shrubs

THE HUDSONIAN ZONE

Looking south on the trail to Grasshopper Glacier. Broad topped trees—White-bark Pine. Spire-shaped near the lake—Alpine Fir.

General View of the Montane Zone Taken from the Lower Hudsonian. Beartooth Mountains

grow only in sheltered locations where wind-driven snow and sand cannot blast them.

Below the alpine zone, between the eight and ten thousand foot levels, we have the Hudsonian, named from its resemblance to the Hudson Bay country. In Yellowstone Park, it is a most beautiful region. About two thirds of the area is timbered and one third open mountain parks. The leading trees are white-bark pine, alpine fir, and Engelmann spruce. The parks are masses of flowers in all shades of red, white, yellow, and blue. No artificial landscape can excel the natural gardens about the slopes of Mt. Washburn and the Beartooth Mountains. The flowers, growing petal to petal, completely cover the ground. In another booklet, to be published soon, their names and something of their relation to man and the animal life of the park will be given.

The Montane, or Canadian Zone, is bounded in a general way by the upper and lower limits of lodgepole pine (5,500-8,000 feet). The larger part is densely timbered with here and there a flower-dotted park. Approximately nine tenths of Yellowstone Park lies in this zone. Of the four entrances, all but the Gardiner lie within it.

Only the small area about Mammoth Hot Springs lies in the Transition Zone. Its plant life resembles that of the Montane, but is also like that of the plains, it is thus transitional. It is unusual for this zone to extend so high (6,000 feet) on the north slope of the mountains. The heavy saline soil may have something to do with it.

A very limited area lying about Gardiner (5,300 feet) which is covered with greasewood, sage, atriplex, chrysothamnus, and grayia might be considered in the Sonoran Zone.

One must not imagine that horizontal lines divide the zones, nor that the plants do not intermingle. On north slopes, the Arctic frequently descends five hundred feet, or in favorable locations the Hudsonian may ascend. The boundary between the Montane and Transition is still more irregular.

PINES, CEDARS, AND JUNIPERS

KEY TO PINES, CEDARS, AND JUNIPERS

Fruit a cone.

Cone scales hard and woody;
Leaves in twos (occasionally threes),
Leaves 1-3 in. long ..... Pinus Murrayana
Leaves 4-7 in. long ..... Pinus scopulorum
Leaves in fives,
Cones opening to discharge seed ..... Pinus flexilis
Cones remaining closed ..... Pinus albicaulis
Cone scales papery;
Cones erect, breaking up on the tree,
Leaves notched at the apex except in fruit-bearing branches ..... Abies grandis
Leaves entire ..... Abies lasiocarpa
Cones pendant;
Branches not much roughened by bases of fallen leaves ..... Pseudotsuga mucronata
Branches much roughened by leaf bases;
Cones 2 in. long ..... Picea Engelmanni
Cones 4 in. long (2-5 inches) ..... Picea pungens

Fruit berry-like.

All the leaves sharp-pointed (shrubs 1-3 ft. high) ..... Juniperus Siberica
Only the juvenile leaves sharp, others scale-like ..... Juniperus scopulorum
Leaves scale-like, trailing shrubs .... Juniperus horizontalis

LODGEPOLE PINE

(Pinus Murrayana)

If this region had been named for its most salient botanical feature, Lodgepole Pine Park would vie with the French and Indian name of Yellowstone. Eighty-four per cent of the Park is forested and three fourths of that forest is lodgepole pine.

In August of each year, the Indians made journeys to these forests to cut and peel the light, strong, slender poles

for lodges and travoys. A pole two inches in diameter at the base and sixteen feet long weighs only seven or eight pounds. No other forest tree tapers so gradually. The average is only one inch to eight feet and some poles can be found whose diameter diminishes only one inch in eighteen feet.

LODGEPOLE PINE AT YELLOWSTONE LAKE

It compares with Douglas fir in strength, with an occasional tree that has a crushing resistance of 824 pounds to the square inch, as against 744 pounds in the fir. Lodgepole pine is the leading forest tree at the East, South, and West Entrances to the Park. At the North Entrance, it is first found near Golden Gate (7,000 feet).

For eight months, these trees coax the moisture from the clouds and store it under their protecting foliage. The average snowfall at Mammoth is 8 feet, at the Upper Geyser Basin 12 feet, and at the Lake 15 feet, which seems remarkable when we consider that this region is almost surrounded by arid districts with less than a 12-inch rainfall. Under the friendly pines, the snow is protected from rapid evaporation and early summer heat. Weeks after the timberless slopes are bare, the snow still lies deep under the trees. It melts in June just when the farmers of Billings and Twin Falls need it to irrigate their beets and alfalfa. The bench farmers of Montana depend on the moisture-laden winds of these mountains. Thus the meat and vegetables on our tables are indirectly furnished by these friendly trees. The eminent geologist, Arnold Hague, says: "Its importance to the nation does not consist of its marketable value, but rather in its power to store up water and to regulate the flow of streams. For this purpose its value is incalculable." It is estimated that the rainfall on forested areas is only two to four per cent more than on similarly situated areas without trees, but the evaporation is fifty-six per cent less. When a thirty-mile gale is blowing, the evaporation under lodgepole pine is only one fourth that of the open plateau.

When forest fires leave the mountainside a bed of ashes, the half-burned cones opened by the heat send down a shower of seeds. In a high wind they may be blown to any distance, but ordinarily they fall within a hundred feet of the parent tree. As the mice, squirrels, and chipmunks are dead, their hoards are also seed beds. The seeds are very small, 100,000 to the pound; but two pounds will sow an acre. Each mature cone-bearing tree averages from 20,000 to 50,000 seeds. Each individual cone has from 10 to 50 seeds. Squirrels are the best judges of fertile cones as every seed hunter knows. Their hoards sometimes contain ten bushels. Cloud-bursts, rains, streams, winds, with immigrating mice, birds, and squirrels help to bury them. The following season, the young trees come up thick as grass, 300,000 to the acre, and a fight for survival follows. In the open, a five-year-old tree may

be knee high and bear a cone or two, the seeds of which are fertile. In dense stands, they may be only eight inches high at that age and no larger than a lead pencil. After a fight of fifty years, the 300,000 trees have dwindled down to 60,000 only eight to ten feet high and not larger than a carpenter's pencil. The forest is now an impassable tangle that no large animal can penetrate. By this time the old forest has fallen, making a mass of crossed poles many feet high. On these fallen trunks one can sometimes cross a jack pine forest by springing from one pole to another like a squirrel. These old trees begin to rot at the heart, but some of the outer shells last a hundred years. All this debris is a fire-trap which may bring a second and more devastating fire. Continual burning destroys the forest. About Butte and Anaconda are areas which have thus been destroyed and on which there cannot be a commercial stand of timber for a hundred and fifty years.

At seventy-five years the forest is half grown. The lower limbs are pruned off by wind and snow. Parasitic fungi have destroyed the overtopped trees. Various kinds of fungus growths destroy the fallen trunks. One can travel anywhere now with horses. There are a few fallen logs but they are easily evaded. Sometimes a falling tree will lodge in a resiny crotch. When the wind springs up suddenly at night, these saw back and forth with most unearthly shrieks. The tenderfoot springs to his feet with visions of mountain lions, but the old mountaineer sleeps on, lulled by the music of Nature's great violin.

As the trees become thinner, the sunshine reaches the forest floor for a few minutes in favorable locations. There we find arnica (Arnica cordifolia), hawkweed (Hieracium albiflorum), mountain oat-grass (Danthonia intermedia), and the large-flowered aster (Aster conspicuus). Shrubs creep into the little openings—bearberry (Shepherdia canadensis), twinberry (Lonicera involucrata), and dense green carpets of huckleberry (Vaccinium scoparium). Quaking aspen which stood side by side with lodgepole the first twenty-five years has been crowded out on the ridges and

now grows only in the wetter locations with the willows, alders, and birches. At the end of one hundred fifty years, there are on an acre only two hundred trees which average twelve inches in diameter and ninety feet high. The largest trees grow along glacial valleys and on north slopes. There is a forest in Beaverhead County, Montana, which averages three hundred fifty years old. Alpine fir and Engelmann spruce crowd it out in the Hudsonian Zone, and Douglas fir coming up from below takes many of the best locations. Lodgepole develops best with twenty-four inches rainfall. Less than eight inches is fatal. Limestone areas, alkali soils, wet, humus lands are not conducive to rapid growth. Mountain parks with black loam soils are too wet and too dry alternately. Where the porosity of the soil is ten to fifteen per cent, lodgepole does well, but a porosity of thirty per cent is fatal, for lodgepole has a short root system and is not adapted to reach for water. More than twenty per cent moisture on sandy soils or thirty-five per cent on loam is fatal.

The clay-colored, prickly cones mature the second season and one third of them open then. On slow-growing, pitchy trees or on trees in dense stands, the cones may remain closed ten or fifteen years. Some resin-bound cones hold their seeds for fifty or even eighty years and are often enclosed in the trunk. Eight per cent of these old seeds are still viable. In spite of this seeming hardihood, a few days in a hot room kills them. This habit of preserving the cones leads one to think of lodgepole as the original "tightwad." The nut pine of Utah excels, for it drops no cones or seeds voluntarily till after death. This habit of holding its cones is the distinguishing feature of lodgepole pine, and enables one to distinguish it at a great distance.

Like Engelmann spruce, it recovers well from the stunted existence of the first thirty years, when, from overcrowding, it has simply marked time. The annual rings of this period are so small that they cannot be counted without a lens. In the open, it is a round-topped, stalwart tree like western yellow pine. Fine specimens of the latter type may be seen

on the plateau above the Lower Falls. It is not a symmetrical tree like Engelmann spruce and from the standpoint of beauty belongs in the balcony rather than in the parquet circle. It always reminds me of the French-Canadians—sturdy, thrifty, undersized, and very prolific. However, this homely tree, like the willows, is apt to be much underrated. The gem of the Park, Yellowstone Lake, is set in lodgepole pine. From the top of Mt. Washburn or the Continental Divide great yellowish-green waves, forty miles from crest to crest, leave the lover of beauty nothing to wish for. On nearer view, the fern-like tops look so soft and so feathery that one is tempted to spring down into them. It is claimed by artists that the yellow-green of lodgepole is the most fetching color in nature.

A short, yellow mistletoe is everywhere common on the limbs of lodgepole pine. In spite of its unpromising appearance, it is said to be as dangerous as the more beautiful species hung over the doors at Christmas time. Mistletoe (Arceuthobium) wounds the trees and causes witches brooms. In winter hundreds of pounds of snow collect on the brooms and bend the whole top over. The central stem recovers its upright position in later growth, making an "S" shaped tree. This is the cause of the knotted forest between the Thumb and the Lake. Mistletoe is more abundant there than at other places. Many trees break under heavy weights of snow, but lodgepole is as tough as leather. The curio store and a part of the hotel at Old Faithful are constructed of these "kneed" trees.

Its greatest enemy is a hidden one (Trametes pini). The fungus spores gain entrance to the tree through a wound and send their mycelia through the wood. In lumber this shows as a brownish rot. When they are well established, they send out yellowish-brown brackets along the trunk. These produce the spores which infect other trees. Timber ants now bore into the softened wood. Their borings look like piles of sawdust at the base of the tree. Then the wind tips it over or an old bear claws it down to get the ants.

Many animals depend upon lodgepole pine. The limit of

animal life is the food supply. The thousands of bushels of seed produced alternate years, and to some extent each year, are not wasted. Pine siskins and crossbills, squirrels, and chipmunks, ground squirrels and mice grow fat among lodgepole. In sparse years they pick up every seed so that it is necessary to poison them in replanting forests. Mountain rats (Neotoma mohajensis) eat the bark for moisture in dry seasons. The porcupine lives on the inner bark and girdles many trees. Snowshoe rabbits nip the buds of seedlings when other green food is scarce. Even the little cony cuts a few limbs for his haystack under the rocks. Flying squirrels and red squirrels eat the buds in spring. The traders and trappers scraped the inner bark for food in times of famine as the coast Indians do to this day. They bake the soft pulp in mud ovens and thus preserve it.

Forests like those in Yellowstone Park do not yield much sawtimber. It runs from 5,000 to 25,000 board feet per acre in mature forests. The miner finds its stiff wood most valuable for mine-timbers and the homesteader uses it to construct all his buildings, his fences, and corrals. Next to spruce and aspen, it makes the best paper pulp of any western tree. Eastern spruce is becoming depleted. Lying near great water-power plants, lodgepole has a most promising future. It is also the coming tie timber for railroads.

Lodgepole pine then, is not to be despised. Without it Yellowsone Park would be a wind-blown plateau sending down great freshets of muddy water. Winding through its pleasant avenues, one may think of it as a loyal friend to man and to all wild life.

"One impulse from the vernal wood
May teach you more of man,
Of moral evil or of good
Than all the sages can"

WESTERN YELLOW PINE
(Pinus ponderosa and Pinus scopulorum)

In coming to Yellowstone Park from the north or west, both the wagon road and the railroad lead through many miles of western yellow pine. It lines the bluffs between Livingston

YOUNG WESTERN YELLOW PINE (PINUS SCOPULORUM)—YELLOWSTONE RIVER, 4,000 FEET
For picture of older trees at the same elevation see first illustration.

and Billings and covers many square miles on the dry plateau below the West Entrance. Western yellow pine, like the juniper with which it grows, loves the sun and consequently grows in open forests. The limbs reach out after light and are widely separated which gives the tree an unsymmetrical,

ragged appearance. (See first illustration.) The roots also are wide-spreading which enable it to thrive on semi-arid areas.

The cinnamon-brown bark is in large, irregular plates made by deep, meandering furrows. It is liberally sprinkled with pitch drops which children use for chewing-gum. In spite of the resin, it withstands fire almost as well as Douglas fir. In youth the limbs are upright, in age they are crooked, drooping, and wide-spreading. The black twigs, when bruised, have the scent of oranges. The yellowish-green leaves, four to six inches long, are clustered on the ends of the twigs. Children enjoy making them into chains by bending the sharp tips back into the sheaths. In the sunshine, the odor of the leaves is as agreeable as that of Colorado blue spruce. It invites the weary toiler to rest a while under the sparse shade to enjoy the appetizing, piny odor. After rain, the needles freshen into deep green. When the raindrops collect along the leaves like rows of pearls, the whole forest looks gray. Shredded leaves are made into sleeping-pillows like hops and are sold as "medicated pillows." The leaves fall between the third and fifth years, making a clean tablecloth where one may enjoy a luncheon. The greater part fall in August, but any dry time seems to bring them down. All knots ooze pitch and the forest floor is covered with it, as everyone discovers who stops to sit there or take a nap. The Indians used this to calk their canoes and to stop leaks in their utensils.

In May the yellowish-brown staminate flowers appear on the ends of twigs, quite changing the general appearance of the tree. On other twigs of the same tree are seen the terminal, dull-red scales of the cone flowers. The pollen is so abundant that it looks like smoke when a sudden breeze arises. It travels hundreds of miles to adjoining states where it leaves a yellow scum on ponds. The pollen of lodgepole pine does the same and Yellowstone Lake is quite clay-colored in July along the shores. The cones are upright the first year and pendulous the second year. They ripen in August. Every third year there is a bumper crop. The cones are reddish-brown, with short, sharp, recurved prickles. On

dry, hot days, they open with a crackling pop. In falling, they leave a few scales attached to the tree.

The seeds have broad wings and in a gale will travel seven hundred feet. A mature tree will reseed one fourth of an acre. It thus makes a good tree to reforest cut-over lands. Seeds from trees under twenty-five years old are apt to be sterile. The best seed comes from the center of cones grown in well-forested areas where there is abundant opportunity for fertilization and the humidity is high. They are larger than the seeds of lodgepole. There are about 10,000 to the pound. Although small, they are eagerly sought by mice, birds, and squirrels. The crossbill has a divergent beak to pry open the cones while he picks out the seed with his tongue. Squirrels handle the prickly cones as deftly as an old cook does a potato. Whirling the thing bottom-side-up, they cut the scales close to the stems and pick out the two sweet seeds at the base of each scale. In less than a minute it is all in pieces on their kitchen middens and they are looking for more. Squirrels often store the cones in brush-piles and hollow logs.

Western yellow pine is very irregular in its production of seedling trees. In a favorable year they reproduce by thousands after which there may be an interval of ten years in which no young develop. Many factors enter into this problem. The mice and birds may find all the seeds, early spring frosts may heave them out if the ground is bare, rabbits may nip every seedling if other food is scarce, or climatic conditions may not be favorable for their development. When the cones are shattered by hail followed by heavy rain, the seeds are buried at once, some of which are sure to escape the seed-eaters. In germinating they bring the seed up like a bean. The first year they are but a two-inch spike without a whorl of leaves, so that counting the age by leaf-whorls, one year must be added to the total to give the correct age.

Along the Yellowstone River, western yellow pine makes its highest development at 3,000 feet. At 4,000 feet, the forest is equally divided between western yellow pine and

limber pine. At 5,000 feet, only a few yellow pines are found. The altitude of Yellowstone Park is thus above its usual limits. Early geological surveys say that it is found there, but I have not been able to discover it. As it encircles the Park on three sides, it seems best to describe it.

Western yellow pine develops best in the shade, but not dirctly under the parent tree. For the first fifteen years, it makes small top development, but a very deep root. For the next hundred years it grows rapidly and reaches maturity at two hundred years. The region of Yellowstone Park is on the skirmish line of this army of pines. In Oregon they attain a diameter of six feet and live to be six hundred years old. There are three geographical races which by specialists are considered species. Pinus scopulorum (Rock Pine) is the smallest and grows principally on the east slope of the mountains. A few stragglers extend to the Iowa line. Its habitat along rocky bluffs doubtless caused Lemmon to give it this name. The distilled oil differs from that of Pinus ponderosa, and the needles and cones are not so large. Two miles east of Bozeman, Montana, the two forms meet and are readily distinguished in this way. The magnificent forests of the Sierras with only one hundred giant trees to the acre well justify Douglas in giving the larger form the name "ponderosa." A still larger form grows in the swamps of Oregon, which is named Pinus Jeffrvii. The attitude of the reader on this question of nomenclature will depend on whether he was born a lumper or a splitter.

Trees growing slowly on dry, sterile soil are heavy with pitch. On north slopes in deep loam the wood is very light and soft. In the long life of this tree, conditions may change so much that we have several qualities of lumber in the same trunk, some being light and soft, while other parts are heavy with pitch. Pinus ponderosa shrinks four per cent in drying and weighs twenty-nine pounds per cubic foot. As firewood it has sixty-three per cent of the value of white oak. It makes a hot campfire with plenty of smoke, but leaves no bed of coals. Pitchy trees make fine kindling when everything else is waterlogged. Pine cones are used to fire boilers.

They have half the fuel value per ton of soft coal. Pine fence posts cut from soft trees last only three years, but the pitchy trees are very durable. Old pitchy trees from which the sap wood has rotted away defy all insects and fungus growths. They are as durable in the ground as cedar. They never rot but wear away by exfoliation. Pine logs put into a building green, or saw logs left at the mill setting one summer with the bark on, are honeycombed by borers. Mountain pine beetles are their worst enemies. A few years ago, after the forests of the Black Hills had been weakened by repeated droughts, pine beetles threatened to destroy the whole forest. Timber in which they work turns blue.

Juniper and alpine fir excepted, western yellow pine has the widest range of any western tree. It extends from southern Canada to the Staked Plains of Texas. In pure stands there is no underbrush or grass and very few flowers or shrubs. The play of sunshine on these clean forest floors reminds us of those unpaintable lights on the bottom of clear, sandy lakes. At night this is rivaled by the checker-board of moonlight shadows.

In the geological column, the pines are very old. "Their hours are peaceful centuries." Their ancestors were here long before Mt. Washburn reared its head. There were few in Cretaceous times, but in the Miocene one hundred species are recognized. Realizing that the pines have seen man come, and will likely witness his departure, Emerson has them say—

> "O'er the graves of men,
> We shall talk to each other again
> Of the old age left behind."

LIMBER PINE (Pinus flexilis)

In the open, grassy park about which the hotel and administration buildings are grouped at Mammoth Hot Springs, we see the low, round head and tapering trunk of limber pine. It is a light-loving, drouth-resisting tree which, further south, in the more intense light of Utah and Nevada, becomes

the leading timber tree of the mountains. In pushing out to obtain light, the lower limbs become long and flexuous. This suggested to James, physician to the Long expedition of 1823, the name Pinus flexilis. Limber pine has five leaves wrapped in leathery sheaths at the base, while the rock pine (Pinus Scopulorum) with which it often grows has but two or three. These light gray clusters are tufted on the ends

LOOKING DOWN SODA BUTTE CREEK

Broad open tops—Limber Pine with characteristic foliage on the left. Spire-shaped—Douglas Fir.

of branches like whisk-brooms. This leaves the center of the tree rather bare, for the leaves cannot withstand the shade of their own branches.

The bright red flowers come in June. The pistilate are almost terminal clusters of scales. The staminate, growing on the same tree, are terminal spikes half an inch long.

Young trees have a light gray, thin, smooth bark. Old trunks are deeply fissured with bark in large rectangular plates. The downy twigs are a light orange-green in summer and gray in winter. The young, green, resinous cones stand erect on the tips of the branches the first season. They grow in twos, threes, and occasionaly fours, and are about one half to three fourths of an inch long. The next summer they grow to be six or seven inches long and turn down on their short stems from the weight. The pines thus laden have the drooping appearance of heavily burdened orchards.

In August the tasty, brown-speckled nuts fall directly under the tree. They are a little smaller than orange seeds and are so heavy with meat and pitch that the wind does not scatter them. It now becomes a scramble among the bears, boys, birds, and mice to see who gets the most. The squirrels have the best of it for they begin the harvest fully a month before the cones are ripe. If the crop is a small one, they may have them all cut before they open naturally. Jays and camp-robbers come next, hammering away as soon as the cones show signs of loosening. Quite properly, the wild life usually takes them all. Occasionally man gets a pocketful. They are very sweet and oily like butternuts. Limber pine is usually confined to the eastern slope of the Rockies. The Snake Indians in early days came over to gather the nuts. They are so much in demand that few are left for reproduction. Sometimes, however, cloudbursts or hail storms bury a few, or a squirrel forgets his hoard. The following spring, seven tiny leaves push up through the stony soil. Ninety-eight per cent of these are whipped to death by winds or nipped by rodents. Only two per cent survive.

The roots are mostly lateral, shallow, and wide spreading. This enables the limber pine to thrive on the "formations," on dry boulder morains, and in rock crevices where deep-rooted trees would perish. Great boulders in the Gardiner River have limber pines growing in the crevices. A tuft of grass, a few asters, nodding harebells, red and green lichens, deep green moss, and a dwarf pine make a diminu-

tive garden on these stones which the cunningest Japanese gardener might envy. Here the annual rings must be counted with a lens, but up on the Continental Divide in deep, loose soil the rings are almost half an inch wide.

When growth starts in spring, the pines send out a whorl of branches around the upright stem. In limber pine, these branchlets are almost horizontal and make a right angle with the central stem. This enables the observer to recognize the young trees at a glance. The number of whorls plus one gives the age of young trees. After they are twenty-five years old, the lower limbs begin to fall and the scars heal over. In cutting and splitting trees for wood, all these old records come to light. Wet and dry seasons, injuries from other trees and animals, fires and lightning wounds are all recorded just as a man's history is written on his body.

Limber pine grows with Douglas fir and Engelmann spruce, but the spruce occupies the marshes and moist loams and the firs the next best locations. Lodgepole crowds it out on the mountain side, but cannot endure the heat and drouth of the lower altitudes. A few straggling limber pines creep down the Yellowstone River to Billings or even to Dakota. In the Hudsonian zone, it meets its nearest relative, the white-bark pine (Pinus albicaulis) which has also five leaves and much the same general appearance. But the bark of the latter is in small squares, the trunks are smoother and whiter, and they commonly grow in groups from a single stump. The cinnamon-brown, short-stemmed cones of limber pine are twice as long as broad, while the purpleish, sessile cones of white-bark pine are broadly oval. The stamens of the former are in oblong clusters, the latter are in globular clusters. The cones of limber pine open at maturity, those of white-bark pine remain closed. The former requires a growing season of four months, the latter thrives with only sixty growing days.

While the thin, gray foliage and low, ragged head of limber pine may be unattractive to the artist, the odor of a broken twig will win the hardest heart. At the first stroke of ax or saw, all the woodland becomes on incense garden.

A scrap of lumber fills the workroom for months with the wholesome pine odor. In our early experience with trees, we are pleased with the symmetrical, as in our early social life, we delight in Italian gardens and dress suits. After this uniformity begins to pall, picturesqueness and individuality are more interesting. From this standpoint, bog birch, desert sage, limber pine, and white-bark pine are as pleasing as the statelier trees.

On the mountain slopes, the limbs of limber pine are frequently covered with a lemon-yellow lichen (Evernia vulpina). It is an air plant and depends on the pine for support only. Mountain grouse feed on this in winter. Old trees are subject to butt-rot and are frequently hollow. In the summer of 1819, a black bear at Mammoth pushed his head into one of these hollows twenty feet from the ground. He was likely looking for ants or honey. The assistant superintendent of the Park discovered him and set the foresters at work to chop him out. A lariat was put around the bear's body and what with chopping and pulling he soon fell to the ground. The large crowd of photographers scattered like leaves in a gale. The owner of the rope was reluctant to part with his property, but let go in a hurry when the bear turned. An old bear might have blamed the first man he met for his whole misfortune. Luckily it was a yearling and he only ran down to the nearest water, got a drink and took off the rope.

Limber pine does not live as long as spruce or fir. Occasionally one reaches four hundred years, but half that age is more common. There are trees 42 in. in diameter two feet above the ground at Mammoth. They taper very rapidly so that there is but one saw log in them. On the Continental Divide, they are taller and taper gradually. In Arizona there are trees with a limb spread of ninety feet and a diameter of five feet.

Limber pine does not make clear stands, but here and there in locations too dry for other trees, it makes a beautiful contribution to the tree life of the Park. It requires but fifteen inches rainfall. Only the juniper can do with less. The light, knotty wood weighs 27 lbs. per cubic foot. It

Courtesy of James C. Witham

ORCHARD-LIKE GROVES OF LIMBER PINE

Alpine Fir on the left. Beartooth Mountains, 7,500 feet.

makes a hot, smoky, sooty campfire and furnishes timber for the mines and an occasional saw log. Its home is in the Rockies between British Columbia and Arizona.

WHITE-BARK PINE (Pinus albicaulis)

At the summit of Mt. Washburn and at similar elevations on other mountains, we find a low, shrubby pine which wrestles daily with mountain winds. It is so tough that the limbs can be tied in knots. The mountain climber always feels safe when one hand clasps a white-bark pine. Further down the mountain it is a low bushy tree. Groups of them in the distance resemble old orchards.

The leaves and flowers resemble the limber pine so closely that they need not be again described and the differences between the two species are also noted under that heading. Squirrels open the cones by gnawing in at the base. By cutting out the central stem, all the seeds are exposed. Jays and camp-robbers hammer them to pieces. They grow on steep hillsides and roll long distances. Wind and rain carry them still further so that the cones are well scattered. If a cone is buried whole it sends up a tuft of seedlings. This may account for their habit of growing in groups. The seeds are more pitchy than those of limber pine.

The bark does not roughen early. On branches and young trees it is near the color of hard maple. This suggested to John Jeffrey, a Scotch botanist, sent out to supplement the work of David Douglas, the name,—Pinus albicaulis, and the common name, White-bark Pine. The bark is fairly bursting with sweet-smelling pitch. While it blackens the hands, it is as healing as balsam.

On the higher peaks, white-bark pine becomes a matted, trailing shrub and is sometimes called Alpine pine or Creeping pine. The buds are often blasted on the windward (southwest) side making the tree one-sided. Some of these trees are very old. A walking stick cut on Mt. Washburn only three fourths of an inch in diameter, had one hundred twenty-five annual rings. Only by the aid of a lens could

they be counted. John Muir tells of white-bark pines that were growing when William the Conqueror landed in England. On exposed places between rocks, the tops are planed off as evenly as a well pruned hedge. One can stand on their dense tops or spread a blanket there. These dwarf trees seldom bear cones. Seed years of alpine or arctic trees

Courtesy of James C. Witham

WHITE-BARK PINE, ENGELMANN SPRUCE AND ALPINE FIR AT THE UPPER LIMIT OF THE HUDSONIAN ZONE, BEARTOOTH MOUNTAINS. AUGUST. 10,000 FT.

Alpine Zone in the background, 11,500 ft.

are very irregular. Lower on the mountain and further south, they are very prolific and trees bend under the burden of cones.

Although continually exposed to fierce mountain gales, they are seldom uprooted. Temperatures as low as –60°, and as high as 100° Fahr. are alike withstood. Like their relative, the limber pine, they thrive on a minimum of soil and

water. In youth they are tolerant of shade, but become less so in age.

The wood resembles limber pine and weighs 26 lbs. per cubic foot. Pitch wood is much heavier. On mountain tops all the timber is yellow with pitch. Such trees do not rot, but are worn away in the sand blasts. It makes a splendid fire, but like all pine, leaves a thick coat of soot on the coffee pot.

On the bleak Beartooth plateau, visible on the eastern horizon from Mt. Washburn, are many square miles above the limit of this friendly tree. Without it the landscape seems desolate and weird. Half freezing in the blankets, pierced by nipping gales, with frozen coffee for breakfast, one realizes that this humble friend is not to be despised. Owing to its location, it will always be exclusive, but the friends who know it will love most heartily its dependable limbs, its daring habit, its sweet odor, its healing balm, and its warm campfires. When the old prospector goes to the hospital, do not send him roses. A spray of alpine pine will bring him a thousand happy memories of days among the mountain tops and restore his courage.

ALPINE FIR (Abies lasiocarpa)

Interspersed with white-bark pine and Engelmann spruce at the seven to ten thousand foot levels, we find the beautiful, spire-pointed alpine fir, the Canadian balsam of the West. It is easily distinguished by the upright cones scattered about the top like plump Christmas candles. When there are no cones, the smooth, light-gray bark covered with pitch blisters, the narrow top, and the pungent odor will serve to distinguish it. It is the most abundant tree on Uncle Tom's Trail to the Lower Falls.

The bark of alpine fir is thin which makes it subject to destruction by ground fires. It is silvery-white to light brown, smooth on young trees, and roughened on very old trees by closely appressed scales and shallow fissures. The inside bark is red which easily distinguishes it if one carries a knife. The copious balsam in large, swelling postules, rank-

ON THE TRAIL TO GRASSHOPPER GLACIER LOOKING NORTH

Tall tree in the center—Engelmann Spruce. Broad top to the right—White-bark Pine. Spire-shaped at the extreme right—Alpine Fir. 8,000 feet.

smelling and thick, immediately closes any trifling wound. It is thus that all conifers are enabled to drown the insects that bore into them. Its heavy boughs look most inviting for a camp bed, but the pungent odor is almost suffocating in a closed tent. While the pitch blackens the bedding and the hands, it forms a liquid skin over abrasions and cuts, most healing and antiseptic. For coughs and colds it has the properties of Canadian balsam.

The limbs are very numerous, upright above and drooping below. They have a tendency to form tangles close to the ground like pin oak. Being very inflammable, they often transfer a comparatively harmless ground fire into a destructive top fire.

The buds are almost round. Like the twigs, they are covered with rusty-colored hairs which drop off with age leaving them a silver white. The deep-green or blue-green flat leaves seem two-ranked by a twist at their base. The leaves are an inch long, rounded at the tip on sterile branches and acute on cone-bearing twigs. They remain on the tree from six to ten years and in falling, leave a smooth scar which enables one to tell it from the spruces at a glance.

The blossoms come in June and are very striking in color. It has violet-purple cylinders on the upper side of the branches and indigo-blue anthers on the under side. The former are an inch long and the latter half an inch. Only the upper third of the tree bears cones.

Alpine fir grows rapidly in moist, cool soil making annual rings half an inch wide. The white wood is very soft and weighs but 22 lbs. per cubic foot. In the soil, it lasts only three years. It makes an excellent grade of paper and a quick, sooty campfire. Dry trees soak up water like a sponge. It is thus poor camp wood in wet weather.

The drooping branches pressed into the earth by snow often take root. The seeds also find a congenial nursery under their mother's apron. Old trees are often thus surrounded by circles of children and grandchildren, making together a pyramid of green. Landscape artists have rarely equalled the natural grouping of trees on the slopes of Mt.

Washburn. Alpine fir is a short-lived tree. When the central tree dies it leaves the younger generations in a circle as mourners. On high alpine slopes where alpine fir is but a creeping shrub, it forms fairy rings about a small grass plot from which the last vestiges of the old parent shrub have departed. There is a beautiful clump of alpine fir just opposite the automobile camp on the shore of Yellowstone lake. It reaches the highest development in the Hudsonian Zone, where there are trees eighty to one hundred feet high and two feet in diameter. As we approach timber line it gradually grows smaller till it is only a crevice shrub. Sometimes white-bark pine outclimbs it, again Engelmann spruce will do so. Quite often we find thickets among alpine boulders with all three growing together in this section. As alpine fir extends further north than any other pine, it is to be expected that it will climb the highest. Going down the mountain, it follows cold shady ravines to 6,200 ft. The lower forests fall victim to disease and borers.

We look under the tree in vain for cones. They never fall but are broken up on the tree. They leave an upright stem about one half the diameter and length of a lead pencil. The seeds are ivory-brown flecked with violet. They are one fourth of an inch long and float away on delicate wings when the cone disintegrates. Trees begin bearing at twelve years and bear a heavy crop each third season thereafter, with lighter ones intervening. The seed germinates better on deep duff than that of any other forest tree owing to the long tap root sent down by the large seed.

It is distinguished from its sister tree, silver fir, by the two white lines on the under surface of the leaf, whereas in silver fir the whole under surface is whitened. In mountain parks an occasional tree has the silvery appearance of Colorado blue spruce.

Alpine fir is the only large tree to reach the arctic circle. Its lower limit is southern California. In the Sierras it grows to be 300 ft. high and five feet in diameter. About five per cent of the forest in Yellowstone Park is alpine fir.

On the Beartooth Forest adjoining the north it forms eleven per cent of the forest.

While its spongy wood is not used extensively because of its remoteness from transportation and its poor quality, it is valuable as a snow preserver and soil binder in those high altitudes where but few trees can survive. Its green, symmetrical spires emulate the church steeples in their suggestions and make our alpine meadows the rival of man's best work in architecture. Like the pines, their history runs back millions of years into Cretaceous times.

"I feel as if I were welcome to these trees
After long months of weary wandering.
Acknowledged by their hospitable boughs
They know me as their son, for side by side
They were coeval with my ancestors."

SILVER FIR or GRAND FIR (Abies grandis)

Silver fir received its name from the silvery appearance of the under side of the leaves. Young trees have a thin, pale, smooth bark with abundance of resin pustules. Its general characteristics are like those of alpine fir and need not be again described. It is distinguished by its larger size, larger and greener cones, its more silvery leaves which on sterile branches have a notch at the apex, and its lower elevation.

Rydberg discovered this tree along the watercourses of the Upper Geyser Basin, but I have been unable to find it and will speak of it as it grows in western Montana.

Silver fir is a tree of the Montane Zone, well scattered among the pine forest. Mature trees are two and one half feet in diameter and one hundred fifty feet high. The branches droop more than those of alpine fir. The bark begins to roughen after fifty years, but is never deeply fissured like Douglas fir. The new twigs are grass-green and the old ones reddish-brown. The pitch pustules are very large. The dry wood weighs only 22 lbs. per cubic foot and like alpine fir, it is coarse, weak, and perishable.

There is no more beautiful tree in our mountains. In symmetry and grace, Engelmann spruce or alpine fir may

equal it, but in color, only the Colorado blue spruce is its rival.

"In such green palaces the first kings reigned
Slept in their shades, and angels entertained;
With such old counselors they did advise
And by frequenting sacred groves grew wise."

DOUGLAS FIR (Pseudotsuga mucronata)

TRUNK OF A DOUGLAS FIR AT TOWER FALLS

About Mammoth, Tower Falls and in many places throughout the lower altitudes of the Park, are found the broad pyramids of Douglas Fir mingled with the pines and spruces. The lower mountain roads leading into the Park have them in abundance. Douglas fir is the leading tree between Gardiner and Livingston. They are found on north slopes as far down the Yellowstone as Columbus (3,500 ft.)

They were discovered by Menzies in 1791 and named by

Douglas thirty-six years later. The name "Pseudotsuga" (false spruce) is a curious combination of Japanese and Greek. "Tsuga" is their Japanese name and "mucronata" refers to their sharp leaves. Douglas considered them midway between the hemlocks and spruces.

The ash-gray bark of young trees is full of resin pustules. It soon becomes deeply furrowed and thick, making a fire protection excelling that of western yellow pine. Fires which completely destroy lodgepole leave many firs. These remnants of older forests are seen throughout the Montane Zone standing head and shoulders above the lodgepole. Bark on old trees is sometimes ten inches thick.

The large, conic, nonresinous buds in reddish-brown scales are clustered at the ends of twigs. The yellowish-brown twigs remain pubescent for several years, eventually turning gray. The twigs, developing from lateral buds, grow several feet in length. They droop as if attached to the under side of the limbs. The drooping twigs and long lateral limbs enable one to recognize fir at a great distance.

In deep shade and dense stands of northern slopes, the whole tree may be clothed in green moss (Usnea barbata). It is not properly a moss but a lichen often called "Old Man's Beard." In the early history of medicine each plant was supposed to be a remedy for that part of the body which it most resembled. The use of ginseng is a survival of this idea. Consequently Usnea barbata was used as a remedy for baldness. Dry and lifeless as this air plant is, it was used by the Indians in times of famine. These moss-covered firs look like some artistic setting of fairyland. One is reminded of the opening lines of Evangeline—

"This is the forest primeval. The murmuring pines and the hemlocks
Bearded with moss, and in garments green, indistinct in the twilight
Stand like Druids of eld, with voices sad and prophetic,
Stand like harpers hoar, with beards that rest on their bosoms."

The black hanging moss, which is also a lichen (Alectoria barbata), is likewise abundant.

Douglas Fir Near Tower Falls

The straight, fragrant leaves an inch long, are light yellow when new and deep green at maturity with two lines of light colored dots on the under surface. They leave a short peg on the twigs in falling. Engelmann Spruce leaves a longer peg. They remain for five to eight years. By a spiral twist at the base, the leaves make flat branches, while in spruce the rank-smelling stiffer leaves radiate in all directions.

In May the tree is a pyramid of fire from top to bottom. Pistilate spikes on the ends of limbs are almost cardinal red, while the staminate flowers in the exils of leaves are an orange red. The green, pendulous cones mature in ninety days. They are three inches long and about half as wide. The cone tips are oval. They are covered with long protruding three-forked bracts. The western form on the Pacific Coast is larger in all its dimensions, but is not so hardy for planting abroad. Douglas fir is very popular for ornamental use in our eastern parks and in Europe. There is a third race in the mountains of California and a fourth in Japan.

The reddish-brown seeds are very small, 95,000 to the pound and are viable for six years or more. They are one fourth of an inch long. The cone sheds its seeds in September, but may hang on the tree till the following year. Trees begin to bear cones between the twelfth and twenty-fifth years. The central scales are most fertile having two seeds each, while the top and bottom scales are usually sterile. Old trees and those of high altitudes do not bear cones. The seeds germinate in late April or early May of the next season, following twenty-five days of favorable weather.

Douglas fir mingles well with other trees or makes pure stands. In the Sierras, their trunks stand so thick and their tops are so dense that less than three per cent of the sunlight reaches the ferns and sedges in the perpetual twilight underneath them. The best stands in the Park are between the forty and fifty-five hundred foot levels. Trees two feet in diameter average about one hundred fifty years old. One fallen monster at Tower Falls was four feet two inches in

Douglas Fir in the Open Surrounded by Young Trees

diameter with 375 annual rings. In Glacier Park, I have counted 570 rings and on the Pacific Coast 575. The largest tree of which we have record was 380 feet high, fifteen feet in diameter and made 60,000 board feet of lumber.

It grows more rapidly than any other evergreen, making trees twelve inches in diameter in fifty years. The stiff, hard wood makes strong dimension timbers, masts, floors, bridges, telegraph and telephone poles. It makes strong doors and beautiful lumber for inside work. The pioneer used it for his house logs and corrals. It weighs 41 pounds per cubic foot and is the stiffest wood for its weight in the United States. Slow growing trees, cut and seasoned in winter, last about eight years in the soil. In winter the pores of wood are better filled with oil, starch, and sugar than in the growing season. Fungi cannot attack seasoned wood as readily as green wood, hence winter cutting is best on all kinds of timber. Trees growing slowly on arid, exposed places are likely to be better filled with oil. When conditions change, as they easily may during the long life of this tree, both hard and soft wood may be found in the same trunk.

Douglas fir makes a snappy campfire throwing out a shower of live cinders to burn holes in tents, camp-blankets, and clothing.

One fourth of all the timber in the United States is Douglas Fir. Eighty per cent of this is found in Washington and Oregon. Only three per cent is held in forest reserves. It is being cut twice as fast as it grows. It does not thrive well on exposed points as the wind blasts the tender buds. Many insects prey upon it, but man is the worst enemy. With his careless methods of lumbering, his matches and careless camp fires, he is fast reducing these grand trees.

Geologically, they are first known in the Pleistocene. In the Park they may thus be regarded as about the same age as the rocks on which they stand.

Forests of Douglas fir are singularly impressive. Their dense canopy brings the restful feeling of twilight. After a hard day's travel in glaring sun and choking dust, how

soothing is their softened light and fragrant air. The hard click of horseshoes against boulders becomes suddenly hushed on the deep carpet of leaves. It is like going from the turmoil of crowded streets into a great cathedral.

"The groves were God's first temples. Ere man learned
To hew the shaft, and lay the architrave
And spread the roof above them, ere he framed
The lofty vault, to gather and roll back
The sound of anthems; in the darkling wood
Amidst the cool and silence, he knelt down
And offered to The Mightiest solemn thanks
And supplication."

ENGELMANN SPRUCE (Picea Engelmanni)

In the deep, cool soil and cold mountain air of sheltered ravines grows one of the most beautiful and least known trees of the Rocky Mountains. It does not thrive on wind-swept summits or arid mountain bases, but prefers sheltered basins where the snow lies deep and the clouds linger to play with the trees. Never is the mountain stream more lovely than when winding through a dark green avenue of spruces, tossing its sparkling spray of pearls into the laps of their caressing branches, flitting in and out of their shadows like a happy, dancing girl.

At the Southern Entrance to the Park, Engelmann spruce forms one half the forest. At Keppler's Cascade it is the tree whose upper third is well covered with two-inch pendulous cones. It makes the deep shade about Apollinaris Spring and lines the roadside along Spring Creek. It is abundant about the east and west entrances and creeps down the Gardiner River to Boiling River, almost to the Park boundary. It is also found at the summit of Mt. Washburn shoulder to shoulder with alpine fir, but here it is only a wind-blown shrub.

The seed of Engelmann spruce germinates best on mineral soils of uprooted trees or avalanche trails. The young rootlets are not strong enough to penetrate the deep duff of forest floors. Seedlings withstand shade better than any other tree.

For half a century, they mark time as they wait for their neighbors and relatives to die. When light comes, they quickly recover and crowd out the alpine fir above and the lodgepole below. In youth, the alpine fir elbows it unmercifully. With Douglas fir, it lives like a brother taking the moister locations while fir takes the dryer. Alpine fir, however, has the best of it for its stronger seeds can penetrate the deep duff and gain a foothold, where spruce must perish.

In open parks along Spring Creek, young trees are somewhat silvery like Colorado blue spruces. In the Wasatch mountains the two spruces intergrade so that it is impossible to draw the line. Blue spruce has larger cones, sharper leaves, denser foliage, and smooth twigs. Engelmann spruce twigs are pubescent for two years. But in traveling from Gardiner to the Wasatch mountains all grades of pubescence are encountered with a gradual increase in the size of cones. There are also all grades of blueness. Moreover, nurserymen find that blue spruce seeds do not come true as to color and obtain their stock by grafting. On the whole, the description of Colorado blue spruce as a variety would seem to fit the facts. It is distinguished from Douglas fir by the rough branches, the rank odor, the four-sided leaves, and the deeper-set, less numerous resin pustules. Its cones do not have the long bracts of Douglas fir and it bears seed only in the upper third of the tree, while Douglas fir cones are as abundant below as above.

Engelmann spruce grows in beautiful pyramids like alpine fir. The sweeping branches of the parent tree hide the seeds and protect them in youth. It is quite common to see groups of tall spruce trees with their children and grandchildren still clinging to mother's dress.

The leaves remain from eight to fifteen years which makes the limbs droop with their own weight. Heavy snow increases this tendency so that an old spruce looks like a giant umbrella. After weeks of rain and snow, a dry bed and dry wood can be found here, but a fire must never be built near them. The duff is deep and dry underneath and will carry a fire over a rainy week to break out and destroy

the forest when the storm is over. Their bark is not thicker than a knife blade and ground fires that would not affect Douglas fir in the least, completely destroy Engelmann spruce. On burned areas, lodgepole pine supersedes them.

Engelmann spruce grows faster than alpine fir. In favorable locations it grows a foot a year while fir makes

Courtesy of James C. Witham

ENGELMANN SPRUCE ON THE COOKE CITY TRAIL
Beartooth Mountains, 9,000 feet.

about two thirds that height. No other tree at the same elevation produces the quantity of lumber. This varies from 5,000 to 30,000 board feet per acre. The lumber is pale yellow and has a pleasant odor. There is no heart wood till the tree is 100 years old. The wood is light, straight-grained, nonresinous, and shrinks in drying only three per

cent. It is soft and does not hold nails well, but does not warp badly or split. It works easily, takes a satiny finish, and rots quickly in the soil. It is often used in making violins and cellos. It does not have the fuel value of Douglas fir. In the Park, trees two feet in diameter are about 150 years old and eighty to one hundred feet high. They have spreading, shallow roots which are often overturned by the wind. Its rate of growth, soil and moisture excluded, depends upon the length of the growing season. Less than sixty days is fatal.

In the state of Washington, Engelmann spruce comes down within 700 ft. of sea level. In Arizona it climbs to 12,000 ft. In the Park the best stands are between 6,000 and 8,000 ft. Three feet eight inches in diameter and one hundred twenty feet high are the maximum. In British Columbia it reaches five feet in diameter and one hundred twenty-five feet high. The adult tree is easily distinguished by its thin bark which flakes off in papery scales somewhat larger than a dime. It never has deeply furrowed bark like pine and Douglas fir.

Staminate and pistillate flowers occur on the same tree. In spring the upper third of the tree is covered with scarlet cylinders half an inch long. Mingled with them are the dark-purple staminate flowers in oval clusters. The ovate, papery cones turn chestnut-brown in August and September. As the scales open, the small, black seeds with oblique wings, float away on the wind. They bear cones every year with an especially large crop every third year. Young seedlings have a tap-root for the first twenty-five years after which the lateral roots predominate. Their worst enemy is a careless man and the next worst is the Engelmann spruce beetle.

Lewis and Clark first discovered this tree in 1805. Dr. Parry first noticed that it is separate from the black spruce of the East. The present scientific name, as Mr. Sargent says in his magnificent "Sylva of North America," "keeps green on a thousand mountains the memory of a wise and good man."

Engelmann spruce dipped in sunshine and cloud alter-

nately, shows beautiful color contrasts in black and white which are rivaled only by the spray of waterfalls against black rocks. Enveloped in clouds, its outline is soft as a dream. Only a few feet away, one rubs his eyes to ascertain whether it be cloud, tree, or shadow. Even as he looks, the cloud may deepen and the faint conelike form perish, or the cloud may dissipate and the magnificent deep green burst forth with all the reality of day. In summer the clouds only play with them, decking them with bridal veils and garlands; but in winter they claim them for their own. When mountain winds are tormenting the firs and pines above, they only rock these giant trees in their protected coves, making them give forth soft, seething sounds like the receding waves on the shore of their far-away friend, the Pacific.

COLORADO BLUE SPRUCE (Picea pungens)

Growing in the rich, moist valleys of Utah, Colorado, New Mexico, and Wyoming, is the Colorado blue spruce. It is often called Parry's Spruce, for it was he that noticed the smooth twigs, prickly leaves, the larger cones with more deeply notched conescales that separate it from Engelmann spruce. The name "pungens" refers to the pungent leaves. Nurserymen distinguish the young trees by pressing the foliage lightly with the palm of the hand. If it feels sharp only, it is Engelmann spruce; but if it pricks, it is Parry's.

Both species have blue trees occasionally, but it is by no means a constant characteristic. In age, all turn deep green and lose their blue tint. In Big Cottonwood Canyon, near Salt Lake City, Utah, all grades of blueness and all sizes of cones are found together. The largest Blue spruce cones are nearly six inches long. From this they grade down to the Engelmann less than two inches long. It is thus more or less a matter of personal judgment as to just the right place to draw the line between the two species. If the large cones are characteristic, it is fairly certain that Colorado blue spruce does not grow in the Park, but if we mean anything larger than the ordinary Engelmann, some of the trees from DeLacy Creek south, would be considered blue spruce. One

tree at Golden Gate is thus identified by the National Herbarium. Typical blue spruce has denser, sharper leaves and thicker bark than Engelmann, with a tendency to fork. It makes a deeper bed of needles than any other conifer, absorbing heavy rains like a great sponge and giving them back in springs and slow evaporation.

Colorado has chosen it for the state emblem, and it seems as if no member of the plant world could be more inspiring. For those advanced in age, mild climates may prove attractive, but for the courageous and the young, the Rocky Mountain states with their pines and spruces will always have a charm.

"Who liveth by the ragged pine,
Foundeth a heroic line.
Who leaves the pine tree, leaves his friend
Unnerves his strength, invites his end."

THE CEDARS AND JUNIPERS (Juniperus)

There are thirty-five species of juniper and cedar in the northern hemisphere, three of which grow in Yellowstone National Park. Scientific books of the more conservative type classify them all as "Junipers." The fruit and leaves of both are very similar.

Juniperus scopulorum

The low evergreen about the "formation" at Mammoth Hot Springs, with bluish-green berries instead of cones, is the Rocky Mountain cedar. On sunny, rocky hillsides, it is so angular, so full of spreading knees and crotches that it hardly falls when cut. It never blows down, though its position on exposed points subjects it to the full force of the wind. On north shady slopes, and in the deep soil along the Gardiner River, it is an upright tree reaching thirty inches in diameter and fifty feet in height.

The bark is reddish, thin, peeling off in long strips. The white sap wood grows very unevenly making an irregular trunk which sometimes encloses strips of bark. This shows as brownish-red patches in the lumber, making, with the red

heartwood, the peculiar mottled lumber we see in cedar chests. The seedlings have a deep taproot, but later the large spreading lateral roots predominate.

The general color effect of the leaves is yellowish or

JUNIPERUS SCOPULORUM (CEDAR) AT MAMMOTH HOT SPRINGS

Showing how the lower leaves are browsed off by game in times of famine.

grayish green. On new shoots, deep green or bluish green is common, turning yellowish in age. Green shades predominate on north slopes and yellow shades in full sunshine. These trees in form, habit of growth, size, color, and seeds

show remarkable variations. About Mammoth, the longer branches, the more shreddy upper bark, the heavily fissured lower bark, and the greater size immediately attract one's notice, after being accustomed to the cedars of the plains. On saplings the leaves are awl-shaped, opposite and prickly, while on mature branches they are smooth and scale-like, closely appressed to the branches. The smooth form is usually found on the upper part of the tree and the long prickly leaves at the base. The tree retains its leaves five or six years.

The male and female flowers are usually on separate trees. The cream-colored, staminate clusters are in the axils of the leaves near the ends of the branches. They come in early spring and are very dusty. The tree has a much lighter appearance when in blossom. A few fleshy scales similarly located, but very inconspicuous, make up the female blossoms. They are but little larger than pinheads and only the three upper scales are fertile. These develop into small greenish berries the first season. At the end of the second season they are doubled in size and we have a sweetish, resinous, two-seeded berry with bluish-bloom like plums. The fruit remains several years if the mice and birds permit. In spite of their turpentine taste, the Indians cook and eat them. The pioneer, far removed from drug stores, ate a few of the berries raw, to stimulate the kidneys. They are very effective and hardly more unpleasant than nitre.

The seeds are not affected in regurgitation or passing through the alimentary canal of animals and are thus propagated by them. Some of the seeds germinate the second year and others lie thirty years awaiting a favorable opportunity. They are rather difficult to propagate, though the lower limbs often take root in contact with the soil. Trees dug with all their roots and soil about them, seldom live when transplanted.

The wood is stiff and soft as every one knows who has sharpened a pencil. It weighs only twenty-three pounds per cubic foot. The crooked trunks, winding in an opposite direction to the sun's path, make very durable posts. There are few left in Montana, but many in the more unaccessible

canyons of Wyoming. Posts set on the writer's farm in 1890 are still doing service. The wood has a pungent sap and oil repellant to insects, making a cedar chest mothproof as well as a thing of beauty. It makes the pleasantest smelling campfire of any western wood and is always dry when others are water-soaked.

On rocky points the tree grows very slowly. Cedars only five inches in diameter are sometimes three hundred years old. Larger trees along the Gardiner River have 565 annual rings. Trees growing on shady hillsides are not so resinous and hence not so durable. On exposed points they creep along the ground like great serpents. Large wounds never heal over as they do in rapidly growing trees. Consequently, injured trees with but a narrow strip of growing surface make flat stems.

Along the precipitous canyon walls of the Bighorn River, there are pure stands of cedar. The limbs seldom interlock. They are independent, light-loving trees that require much sunlight and plenty of room for their wide-spreading roots. These exposed arid slopes seem to be their favorite haunts and it is here that they bear seed most abundantly.

The dead trees never rot but wear out in sandblasts. Fungi cannot penetrate their dense trunks filled with pungent oil. Mosses and lichens attach themselves, and their acids break down the tissues as they do the rocks. A red rust on the leaves of service-berry (Gymnosporangium juvenescens) has its alternating generation on this tree producing galls and witches brooms.

Sudworth, in his delightful book, *Forest Trees of the Pacific Slope,* classifies the junipers about Mammoth as Juniperus occidentalis. In form and size they strongly resemble that species. In leaves and fruit, however, they must be classified as Juniperus scopulorum. Specimens sent the National Herbarium from that region have thus been determined.

Further down the Yellowstone, they form beautiful pyramids and clumps which we long to transplant in the home lawn. This is the more common form at lower altitudes.

In the mountains about Butte, Montana, there is an upright form with a dense, narrow, cone-shaped top which is often used as an ornamental shrub in gardens and cemeteries. In other places they may be low spreading clumps only three feet high, or again trees twenty-five feet high with a deeply

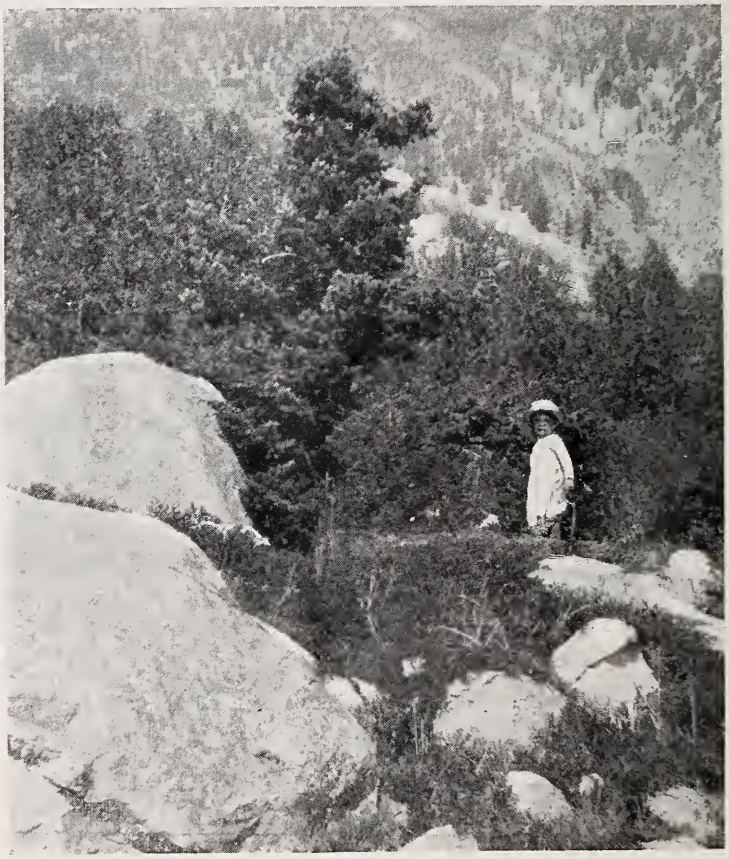
JUNIPERUS SCOPULORUM SHOWING THE MORE COMMON FORM ON THE LOWER YELLOWSTONE, 4,500 FEET. PINUS SCOPULORUM IN THE BACKGROUND

fissured bark. Like wild apples, seeds grown from a single tree show the widest variations. A critical student can thus make any number of species.

Juniper, in the language of flowers, signifies protection. We use it to line the graves of our friends hoping their memory will be as enduring as its fragrant branches. The Indians used to burn the leaves in their religious ceremonies

or sprinkle them about the floor of the medicine houses for fragrance.

Rocky Mountain cedar, or juniper, differs but little from the eastern cedar (Juniperus Virginiana) and when nomenclature has become more rationalized, may be properly associated with its eastern form.



CREEPING JUNIPER AMONG THE BOULDERS

Dark green tree—Douglas Fir. Lodgepole Pine in the background.

SIBERIAN JUNIPER (Juniperus Sibernica)

While cedar has prickly leaves on juvenile trees only, the Siberian juniper has sharp-pointed, boat-shaped leaves throughout. The flowers and seeds are borne along the branches instead of at the ends of twigs. The deep-channeled leaves have a bluish bloom. It is a spreading shrub about three feet high. There is a fine display of Siberian juniper on the north slopes at Golden Gate and at the Natural Bridge. It climbs the divide along Spring Creek to 8,500 ft., and descends the valleys far below the Park lines.

TRAILING JUNIPER (Juniperus horizontalis)

Trailing juniper creeps along the ground forming beautiful mats. Its leaves are smooth and appressed like cedar. As the outside of the mat widens, the inner part may die making fairy rings several rods in diameter. The berries are on recurved stems. It has a wider range than either of the others and grows across the continent at elevations as high as nine thousand feet and as low as two thousand. It makes a pretty carpet on which children like to play, or a fine mattress on which to spread the blankets.

NARROW-LEAF COTTONWOOD (Populus angustifolia) AND BALSAM POPLAR (Populus balsamifera)

Balsam Poplar grows along the lower courses of the Lamar and Yellowstone rivers, but there is one fine grove on Stephen's Island in Yellowstone Lake. It is the Balm-of-Gilead of the West and differs but little from the eastern tree. During the crusades, a group of poplars growing near Gilead in Palestine, furnished a healing gum for the wounded knights. This accounts for its common name. The scientific generic name comes from the fact that they were abundant along the streets of ancient Rome. Every student of Latin will remember that "populus" means people and they were no doubt a good friend to the common man just as they are today.

The tree blooms in April or May according to the altitude and is about a week later than the aspen. As the red, staminate blossoms lengthen, the sticky sharp-pointed scale buds fall, covering not only the ground but the coats of all

COTTONWOOD (POPULUS BALSAMIFERA) ON THE YELLOWSTONE RIVER BELOW THE PARK, 4,000 FEET

the animals that happen to lie under it. If the buds are collected and hot water poured over them, a sweet-smelling resin may be skimmed off after it is cool. Before the days of drug stores, the pioneer boiled the buds in lard and used the salve for cuts, burns, and bruises.

Just as the blossoms fall, the shining, olive-yellow leaves appear filling the air with the same fragrance. The leaves are ovate, sharp-pointed, and thick margined. The under surface is lighter colored than the upper with resinous rusty spots and reticulate veins. The leaf stems are somewhat flattened making them susceptible to the slightest breeze. The pistilate catkins resemble half-grown clusters of grapes. These bolls burst in July scattering the tiny, cotton-covered black seeds for many miles. After a quiet day, a sudden gust of wind will bring down so much cotton that it resembles a snowstorm. For this reason they are undesirable in the city. In youth, male and female trees cannot be distinguished, however, if pistilate trees are pruned back heavily, they do not bear cotton for four years. In the Park where there are not so many people, the shower of cotton is a pretty sight. It is Mother Nature's confetti. Like the aspens and willows, the seeds are viable for only a few hours in dry weather or for but a few days at any time.

Cottonwoods are a great favorite with the beaver. Along the Lamar they have cut trees sixteen inches in diameter from which the smooth, green tops have been taken for food. Horses and cattle also thrive on the bitter bark. Birds, squirrels, and even water voles eat the buds and blossoms. At the very top of the tree, the blue heron builds her nest, farther down the robin anchors her neater domicile to the rough bark, and among the twigs at the base, where even a little child may look in, we find the two pure white eggs of the mourning dove.

Poplars propagate largely by sending up suckers from shallow roots. In this way the parent tree becomes surrounded with a host of children, making symmetrical, wind-resisting clumps. Until the rough bark is formed, they are easily killed by ground fires.

There are twenty-five species of poplar, half of which are indigenous in the United States. They show many variations which specialists are tempted to make into species. The cottonwoods of every locality have peculiarities. Surely man ought to be able to understand this! Between Populus bal-

samifera and Populus angustifolia there is every grade of intermediates. The balsam poplars in the Park have unusually narrow leaves.

Balsam poplar reaches its climax in the Mackenzie valley. It is the prevailing deciduous tree on the east slope of the Rockies and extends through our two northern tiers of states. In Canada there are trees six feet in diameter and one hundred feet high. One old tree on the lower Yellowstone measures nineteen feet six inches in circumference eighteen inches above the ground. The top is broken down by snow so the height cannot be measured. Notwithstanding the ravages of man, cottonwoods seem to be increasing as the beaver decrease. The beaver was an inveterate wood cutter. On small streams every tree was cut and he made detours of a quarter of a mile for food and brush for his dams. They reforest the river bottoms very rapidly. A cottonwood cut on the Yellowstone below Livingston had grown to be two feet four inches in diameter and eighty-one feet high in fifty-seven years. The diameter at ten years was nine inches. The annual ring of the seventh year was five eighths of an inch wide. The bark began to roughen the thirteenth year and there were two good sawlogs in the body. This was in a thick grove. In the open they grow still more rapidly. The cottonwoods on Stephen's Island are twelve inches in diameter. They seem perfectly at home, healthy, and have symmetrical tops, but for some reason they do not climb far above the seven thousand foot levels.

Poplars make a large contribution to the beauty and comfort of our West. In spring the early blossoms, the balsam-laden air, the shining green leaves make a day among them very pleasant. In summer the otherwise bleak pioneer cabin looks very homelike under their cool shade. They respond so cheerfully to the delicate, harping fingers of the wind. Isaiah must have been sitting under a cottonwood when he wrote: "The mountains and the hills shall break forth before you into singing; and all the trees of the field shall clap their hands." When sitting under a cottonwood with a friend it is so easy to tell everything. Even strangers cannot

remain estranged here, but break the ice and have a friendly chat. In autumn there are the yellow fringes along all of our western streams. The trees may be decorated with prairie chickens and the interior may contain a few pailfuls of white clover honey. In winter there is the delicate tracery of limbs against the winter sky and a pile of clean, sweet-smelling wood for the fireplace or campfire.

The wood is brittle and heavy when green, barely floating. When dry it is very light and stiff, weighing only 23 lbs. per cubic foot. It makes good paper pulp, boxes, pails, fruit crates, and lumber for inside work where sun and wind are not factors. It mildews easily when being cured and warps badly in the pile unless stripped very carefully. In the soil, it rots in three to five years. The dry wood has half the fuel value of white oak. It is clean and sweet-smelling for household use and makes a splendid campfire when dry. On account of its strength and lightness, the farmer values the lumber for hay-racks and wagon boxes.

Before the glacial age, the poplars were more plentiful than at present. Besides our forms, one hundred twenty-five species were then known. In the Eocene, they are the most common plant fossil, and far back in Cretaceous times, the dinosaurs basked in their shade. Their work, geologically, like that of the aspens and willows, is to bind the soil.

Balsam poplar is a boon to the western pioneer. In five years he can have splendid shade and protection from the wind around what, otherwise, might be a bleak home.

Few plants and shrubs thrive under the shade and in the acid soils of the pines, but cottonwoods are very hospitable. Dense thickets of cherry, rose, buffalo-berry, and service berry grow in the rich soils beneath them, fertilized and protected by annual coats of leafmold. Thus, while the pine thickets make an excellent windbreak, buffalo, deer, elk, and sheep prefer the willows and cottonwoods where there is grass and water with an occasional shrub to nibble.

NARROW-LEAF COTTONWOOD (Populus angustifolia)

Narrow-leaf cottonwood has leaves that are green on both sides and about half the width of the above. Its general characteristics are the same and need not be again described. It is found at Gardiner and along the Lamar River.

(Populus nigra)

Along the ditch bank at Gardiner are a few imported poplars which the National Herbarium classifies as (near) Populus nigra. They are out of their range and winterkill badly. Their forlorn appearance is an example of what might happen if we attempted to "beautify" the Park. It has always been a source of great satisfaction to many visitors, that the native shrubs and trees were preserved and that foreign plantings were not encouraged. At the West Entrance, what landscape garden could excel the clean, flower-dotted forests of lodgepole? The natural forests of spruce and fir and pine at the East and South Entrances are equally inviting. The arid sage and shrubby desert plants of the Gardiner entrance give a graphic picture, in miniature, of the greater part of Wyoming. The many willows, aspens, pines, junipers, and cedars about Mammoth Hot Springs are more artistic than Italian gardens in that location. They preserve the local color.

ASPEN (Populus tremuloides)

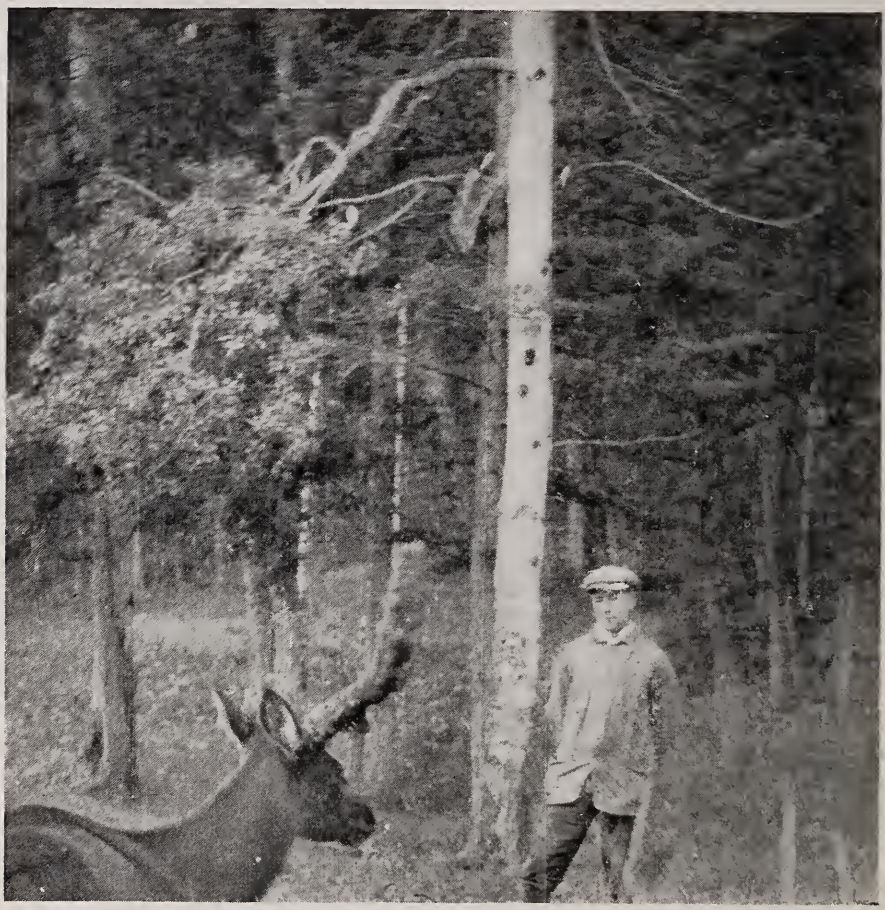
Aspen is by far the most abundant deciduous tree in Yellowstone Park. From the hotel at Mammoth Hot Springs, light green patches of aspens are visible everywhere on the mountain sides in marked contrast to the dark green firs and pines. In the prairie states they are called tow-heads. As they spread mostly by roots, the patches are roundish with the oldest trees in the center. The staminate and pistillate flowers grow on separate trees. Small clumps are usually all male or all female. But unless the trees are in blossom or fruit, it is impossible to distinguish the sexes, much as the nurserymen would like to do so to avoid the cottony females.

As the sunshiny days come on in later February and March, the smooth ash-gray bark of the upper trunk turns olive green. Early in April, while the snow may still be shoulder deep, the male tree opens its seven thin, shining, reddish-brown scale buds. These stand open like ripe nutshells for a week while the deep-purple catkins lengthen. The scales fall a few days before the blossoms, making the ground quite red with their sticky foliage. These and the plainer green catkins of the female trees are the second earliest blossoms of spring, alder being first.

The bees go wild over these nectar-laden blossoms, being too busy to fight each other or resent an insulting blow from an outsider. After all the nectar loving insects and the winds have performed the marriage ceremony, the balsam-smelling, olive-colored leaves burst forth, looking as waxy and fresh as the first in Eden.

Soon the male catkins fall, but the female, with their grapelike clusters, grow till the green bolls are as large as peas. In July, they open and the obovate seeds, only a thirty-second of an inch long, float away, surrounded by a tuft of cotton. In the absence of a breeze, the seeds make a dense cottony mass about the parent tree, resembling a light fall of snow. But it is much more likely that they will drift away on the wind to begin the life cycle anew. Thus, like the willows, they are among the first trees to reforest a region completely devastated by fire, and like the willows again, the seeds must find suitable soil within a few days or they dry out and perish. Like the birch, they become the foster mother of many of the hardier and more valuable trees that need shade and protection in youth. For the first twenty-five years, they grow side by side with lodgepole on the mountain side. Finally they are overtopped by their taller companion. In dense stands of lodgepole, they are smothered the second year. About springs, however, they hold their places and reach an average age of seventy-five years. Sargent reports trees two hundred years old. At 10,000 ft., in the Wasatch mountains, they form thickets but three feet high on the summits. At sea-level on our western

coast they are small trees. In Yellowstone Park they reach their maximum development between the 4-6,000 foot levels, making trees twelve to eighteen inches in diameter. In south-



ASPEN TREE AT THE ROOSEVELT CAMP
Pine in the background.

ern and eastern Wyoming, the trees grow larger and the trunks are whiter. In the long growing season of Arizona, they reach the maximum of 10,000 feet, where Sargent reports

trees forty inches in diameter and one hundred twenty feet high. Most of the driftwood of arctic regions is aspen and cottonwood. Again we find them on the tablelands of Mexico and in northern Europe and Asia.

With all these varying climates and conditions there are of course many forms of leaf and stem. In my herbarium are aspen leaves six inches long and others less than one inch. Sometimes the length is twice the width and again the width is twice the length. Any number of species can be made. The National Herbarium determines the Park form as Populus aurea.

During Indian wars, our pioneers made aspen corrals for their stock at night. In the morning the poles were peeled white by horses and mules, while the oxen thrived on the bitter twigs and leaves. Aspen bark is the favorite food of beaver. They fell the trees very quickly and cut the larger ones into two-foot lengths that can be dragged to the ponds and buried in mud. It takes a beaver only twenty minutes to fell a three-inch aspen. Small trees are cut in proportionately longer lengths. The sound judgment of the beaver in handling timber is a constant source of surprise and wonder. Lie still in the grass along Chalcedony Creek some moonlight night and watch him work. Forever after he will not be an animal, but a little brother. After the pine nuts are exhausted the Douglass squirrel and Fremont squirrel nibble the aspen buds and bark. Mice often girdle the trees and birds eat the buds in spring when the berries are gone. In times of famine, elk and deer girdle aspen groves. If these trees were cut early in the following spring, they would send up a mass of suckers from the surface roots. The diameter of the root area is many times that of the top, and the area of the stand would thus be increased. In experimental plots at Absarokee, Montana, each tree felled in June sent up ninety thrifty saplings. They are eighteen feet high and two inches in diameter at four years old. Old trees, in open places which are above the reach of game, may be cut and the forage supply increased. In the shorter growing

season of Yellowstone Park, saplings would not grow as high as at Absarokee (4,000 ft.).

While aspen requires a moist subsoil, it does not thrive on lands which overflow. Black loam just above the water level is the favorite habitat. Continued tramping by stock kills them. The same blight which attacks pear trees (Bacillus amylovorus) turns the twigs and leaves black as if they had been scorched by sudden heat. A parasitic fungus (Fusiladum radiosum) turns the leaves black in spots which may spread to destroy the entire leaf. These diseases destroy five per cent of the trees annually in the lower altitudes on the Yellowstone, but in Yellowstone Park the percentage is much lower.

Aspen twigs have orange-colored lenticels. The heart-shaped, short-pointed, crennate leaves are green above and lighter below. It is probably of northern origin, for the sticky buds for next season's growth develop very early in summer. Autumn leaves turn a brilliant yellow with an occasional tree in dry location imitating the hard maple. These autumn tints are not caused by frost, though frost hastens the maturing of the leaves. The color pigments are developed in the natural process of ripening and are most brilliant in seasons when frost is long delayed. Trees and shrubs that show brilliant autumnal colorings usually show the same colors in the juvenile leaves of spring. Therefore the chemical constituents of the plant probably account for it. Yellow aspen clumps add much to the beauty of Yellowstone Park in later August and September. Aspen makes a good grade of paper pulp and when planed has a fine satiny finish. It weighs twenty-five pounds per cubic foot.

The leaf-stem of aspen is flattened at right angles to the leaf, which makes it susceptible to the slightest breeze. Even when the mouth-warmed finger fails to detect a breeze, some nodding aspen leaf stoutly affirms that there is one. If one were blind he could still recognize aspen by the rustling sound of its leaves. Lowell says, "Only the pattering aspen made the sound of growing rain." They seem full of secrets and whispered colloquies like a flock of birds or happy chil-

dren. What wonder that the old Greeks peopled the trees with dryads and fairies! We cannot deny that trees speak to us. They issue warnings and invitations. They make suggestions which profoundly influence us. How unfortunate that the material life of the Occident has blinded us. The dryads are still there, but we do not see them.

Geologically speaking, the aspens are very old, antedating man by thousands of centuries. In literature, also, they date back to Homer. The Odyssey, in speaking of the graceful motions of the spinners, says—

> "Some wove the web
> Or twirled the spindle setting with a quick
> Light motion like the aspens' lancing leaves."

In Arabic, "aspen" signifies trembling. Thus we find the name almost as old as written language.

The friend and companion of the aspen is the spring. The trickle of a spring, the airy soprano of the aspen, and the deep alto of the pines make a wonderful trio. It invites birds to visit or friends to sit and chat. No one can keep a secret under the aspens. In their vivacity and love of expression, they remind us of our Latin friends about the Mediterranean.

WILLOWS

KEY TO THE WILLOWS

Capsules Glabrous to thinly pubescent.

Scales pale yellow, deciduous.

Stamens 3 to 5, leaves lanceolate, finely serrulate, trees.
Petioles and leaf-bases not glandular...Salix amigdaloides
Petioles and leaf-bases glandular.....Salix fendleriana
Stamens 2, leaves linear, shrubs .....Salix exigua

Scales brownish to black, persistent.

Styles none. Minute, prostrate plant .....Salix Dodgeana

Style distinct, Shrubs.

Styles 0.3 to 0.7 of a mm. long, aments pedunculate, leaves and capsules glabrous.
Leaves pale beneath, broadly lanceolate.....Salix lutea
Oblanceolate or obovate .....Salix Mackenziana

Leaves deep green on both sides—

Ovate or obovate, thin .....Salix pyrifolia
Eliptic-lanceolate, thick .....Salix pseudomyrsinites

Styles 1-2 mm. long:

Aments pedunculate (If sessile, leaves not glandular)
Leaves glabrate above, aments sessile S. pseudomonticola
Leaves glabrate above, aments pedunculate..S. Barclayi
Leaves villous-tomentose to glabrate.....Salix Wolfii
Form with larger leaves.....Salix Wolfii idahoensis
Aments sessile, leaves glandular.....Salix Tweedyi

Capsules Hairy.

Style over one mm. long.
Leaves pubescent on both sides or upper surface only.
Subalpine shrubs 2-15 dm. high.....Salix brachycarpa
Alpine shrubs less than 1 dm. high.....Salix petrophila
Leaves densely pubescent below, glabrate above
..... Salix subcoerulea

Leaves bright green on both surfaces.

Leaves broadly eliptic-ovate, obtuse....Salix chlorophylla
Leaves oblanceolate, acute .....Salix Nelsoni

Style obsolete, less than 0.3 mm. long.

Tall, erect shrubs. Capsule conic-rostrate.

Aments stout, dense, sessile. Stigma slender ..... Salix Scouleriana

Aments lax, leaves eliptic-ovate .....Salix Bebbiana

Aments lax, leaves linear-oblanceolate...Salix Geyeriana

Low depressed or creeping shrubs.

Leaves suborbicular, 1-3 cm. long .....Salix saximontana

Leaves less than 1 cm. long .....Salix nivalis

NOTE: For the above key, I am largely indebted to Coulter and Nelson's *New Manual of Botany*. Mr. Carleton R. Ball has kindly determined the more difficult species of willows.

THE WILLOWS (Salix)

Everywhere along the watercourses are the willows. Twenty-five of the two hundred known species are represented in Yellowstone Park. The visitor unacquainted with western life, may consider them valueless; but they would be missed more than any other tree. The Indians utilized them for baskets, travoys, and cordage. In their domestic arts, willows were indispensable. To this day, the southern Indians use them to construct their wattle houses. The Crowes bent their pliable trunks over heaps of fire-heated boulders, covered them with robes, and added a dash of water to make their medical steam-baths. Growing close to earth, their thick tops and dense foliage make the best wind-break of any of our western trees. How eagerly both the horse and the rider of our wind-blown plains turn down to the willows at night. There is water, grass, shelter, dry wood for a clean, smokeless fire, and later a good bed of coals to smoke by. The pioneer stockman finds the willow thickets more practical than a stable and almost as warm. Moreover his sheep, cattle, and horses browse the slender twigs in time of famine. During heavy snows, deer, elk, mountain sheep, and moose subsist on willows. Moose yards are only willow thickets where deep snows are weathered.

The boy looks to the willows for his whistles, ballbats,

fishpoles, and the string to carry his fish. His sister, with the birds, finds their thick umbrella tops a homelike place to play. All rodents eat willow bark when the snow lies deep. Insects depend upon them for food more than upon any other tree. Next to aspens, they are the favorite food of the beaver who bury their pliable tops in mud and make a dam which an engineer might envy. As all animal life requires water, their proximity to streams is doubtless one of the secrets of their popularity. Their graceful flag is always a signal for water.

DODGE'S WILLOW (Salix Dodgeana)

On the cloud-mantled summit of Electric Peak, a thousand feet above the last dwarf pine, are forests of willows so small that several hundred may be held in the palm of the hand. These compact, pygmy forests might easily be mistaken for moss. They grow on moist soil or bare rocks below dripping snowbanks, for even here the willow must be close to water. Its scientific name, "Salix," comes from two Celtic words, "sa" meaning near and "lis" meaning water. On Electric Peak this venturesome tree is composed of one slender twig, one half the length and diameter of a match, and a single leaf and "pussy." The nectar-loving insects swarm about it as they do about its larger relatives. A heavy bee brings down the whole tree while he sips the nectar with his back on the ground. Sixty sunny, frosty mornings with as many windy afternoons and nights, interspersed with daily snowstorms, form its entire growing season. It trails along the ground like a vine, taking root at every bud. The twigs are yellowish, the leaves oblong or oval. It was named after William E. Dodge of New York City, who was for many years a liberal patron of botanical research. Thus far it has been found only on Electric Peak, Sheep Mountain, and on the Tetons.

ROCK WILLOW (Salix petrophila)

Low down among the grasses and sedges of Mt. Washburn, we find the Arctic Willow, or Rock Willow. Its size

and habit are like the above, but it has pubescent leaves and capsules, while Dodge's willow is smooth. It climbs higher on the mountains and creeps nearer the north pole than any other shrub. On Mt. Washburn it is only two inches high, but in a deep ravine near the West Entrance there are shrubs over one foot high. It is common everywhere on the higher mountains. "Petrophila" means lover of rocks and it is on dripping rocks that it most often is found.

ROCKY MOUNTAIN WILLOW (Salix saximontana)

Further down the mountain at the edge of the timberline, we find a creeping or upright willow with roundish leaves which are prominently veined below. The leaves are about one inch in diameter and the tree a foot high. This is the Rocky Mountain Willow. It is common on alpine summits of the central Rocky Mountains.

SNOW WILLOW (Salix nivalis)

The snow willow grows above the Rocky Mountain willow. The leaves are but half the diameter of that species and have a notch at the apex. Its habit of growing near snow doubtless gave it the name. It has the same range and may be only a diminutive form of the other. In Yellowstone Park it has been collected only on Electric Peak.

TWEEDY'S WILLOW (Salix Tweedyi)

Along the upper course of Slough Creek, we find Tweedy's willow named for one of the early explorers of the Park. It is a smooth, black-stemmed willow about six feet high with glandular, broad leaves. It grows in black muck along the edges of lakes. The first two feet of the stem are prostrate on the soil from the great weight of winter snow. The leaves are very broad at the apex so that shorter ones are almost round. It makes broad mats rather than tufts.

BARCLAY'S WILLOW (Salix Barclayi)

Barclay's willow grows lower on the mountains. It is in clumps but not matted. It is an upright tree eight to twelve feet high. It has been collected as far down as Mammoth (6,000 ft.) but thrives best along Spring Creek, at Old Faithful, DeLacy Creek, and the upper part of Soda Butte Creek. There are a few shrubs at the Lake.

SAND-BAR WILLOW (Salix exigua)

Along the sand-bars of mountain streams, by irrigation ditches and open sunny swamps, we find the sand-bar willow in abundance. It is easily distinguished by the long, narrow, serrate leaves. It never strays away from the water as many willows do. It spreads from the roots and makes dense thickets. Never does the white spray of a dashing mountain stream look more beautiful than through the filmy foliage of this pretty tree. In clumps, it has all the grace of oriental bamboo. All river life loves this tree. Otter and mink glide through its protecting screen to pounce upon the fish that are feeding on the insects of its overhanging branches. The western rancher, imitating the beaver, ties it into bundles to divert the swift mountain streams. The fur trapper and Indian scout of the sixties made his campfires among them. Then lest a gleam of fire or a wreath of smoke would betray his temporary home to the watchful savage on the bluff, he hid his furs, and with rifle and blanket sought sleep further away among their protecting boughs. When, after months of travel, his stock of salt was exhausted, he dipped the moist meat in clean willow ashes as a substitute. Ashes and smoke preserved his meat. Willow twigs made his toasting fork for it did not taint the meat. Willow bark tanned his skins or made a tea to cure his rheumatism. The Indians made water pails of it by first making a basket and then coating it with pitch. The tourist who has forgotten his tooth powder, will find willow ashes a good substitute. The bark is very tough, but the wood is brittle as every boy knows who goes out to cut a "gad" for his friend. In the little red

school house, willow was one of the three leading branches, much more humane than birch or hickory. Some of my readers may remember that they owe their start in the straight and narrow way to the willows. Willow bark was the cordage of the Indian, the trapper, and the pioneer. Air-dried willow bark yields ten to thirty per cent of commercial fiber.

Sand-bar willow is abundant in the Park between Gardiner and Mammoth. It climbs the mountain to 7,500 ft. where it becomes a low shrub, and descends the Yellowstone, Missouri, and Mississippi to the Gulf where it is a large tree a foot in diameter. The largest trees in Yellowstone Park are four inches in diameter and sixteen feet high. A diameter of one inch and a height of eight feet are about the average. About Mammoth and Gardiner they are browsed down to mere stumps. Above Golden Gate they make less than one per cent of the willow forest. Its scientific name means "insignificant willow," but it is certainly a most significant shrub for the game. One of the most serious problems in all our northern parks, is to provide food for the game during deep snow. In early days the game came down into the lowlands. Now they are stopped by fences and herders. Feeding hay is expensive. Moreover, game will not "rustle" when fed, but become entirely dependent. Each year the supply of forage available in deep snow has diminished in the lower altitudes, till in Yellowstone Park it is practically exhausted. Only trees hanging over streams and those too high for the game to reach are left. In this emergency, they girdle aspen forests or browse unpalatable foliage like juniper and skunk brush (Rhus trilobata). Salix exigua is easily planted from cuttings or root fragments, it is a beautiful ornament, it is hard to exterminate, it is nutritious, and the game like it. It may be feasible to replant the moister areas in the Park where game congregate in winter.

Spring is the best season for artificial propagation. Two year old twigs have the most vigorous buds. They should be used fresh before they dry out. They are planted very rapidly by pushing the twig into the moist earth as far as it

will go at an angle of forty-five degrees. Then placing the foot firmly over the soil above the twig clip it off with a sharp knife so that only one bud is exposed. Continue with the remainder till the twig is used. Pressing down the soil is important. If summer cuttings are used, all the leaves should be stripped. If several buds are exposed, greater losses will follow.

PEACH-LEAVED WILLOW (Salix amigdaloides).

Between Mammoth and Gardiner is a group of willows which have probably been planted. They are above their usual range but are very thrifty. They are over sixty feet high with trunks two feet in diameter. Salix amigdaloides is the largest willow in the Park. Their graceful, drooping foliage reminds us of the paintings of Corot.

FENDLER'S WILLOW (Salix Fendleriana)

Fendler's willow is the next largest willow of this region. It is a rough-bark tree growing singly or in twos and threes from a common stump. The long, taper-pointed leaves have a tendency to cluster on the ends of twigs. The wood is not durable in the soil. Old trees are commonly hollow. It grows along the Lamar and lower Yellowstone. Salix Fendleriana reaches its upper limit at 6,000 ft. where it is a slender shrub ten feet high. On the lower Yellowstone it makes small trees a foot in diameter and forty feet high. It is distinguished in early spring by the lemon-yellow twigs and branches. It does not send up suckers or spread by the roots as readily as many other willows. When cut, the old stump frequently dies.

YELLOW WILLOW (Salix lutea)

Another shrub which reaches its altitudinal limit at Mammoth, is the yellow willow. The trunks are not yellow, however, but a light ash-gray. The twigs are yellowish but turn red in the sun. The leaves are light colored on the under side with a bloom which rubs off as it does on ripe

plums. When the wind exposes the under surface, the whole tree has a grayish appearance. It grows in graceful clumps about twelve feet high. About Gardiner it is very abundant, but suddenly disappears as we climb the mountain. There is a clump at Golden Gate and another at the Fountain which are above their usual elevation.

DIAMOND WILLOW (Salix Mackenziana)

Diamond Willow just reaches the Park but is very rare. There are a few clumps on Mt. Evarts. As twigs die along the lower stem, the bark is attacked by fungi or bacteria which kill a diamond-shaped area from one to three inches long. As the stem increases in size these areas do not grow but form depressions. When the diamonds are abundant, the carved trunk makes a very pretty walking stick and is often carved and polished for that purpose. Further down the Yellowstone it is very abundant and makes stiff angular clumps twenty feet high. The wood is as durable as oak in the soil and is used by the farmers for fence posts. Trappers of early days often selected the tough, light wood for snowshoes.

GREEN-LEAVED WILLOW (Salix chlorophylla)

Salix chlorophylla, as its name implies, is characterized by its deep green leaves. The twigs and stems are almost black and shine like the glossy leaves. It is an upright shrub about ten feet high which grows in cold swamps or wet areas of the upper Montane or lower Hudsonian Zone. It is found at Old Faithful and along the trail to Grasshopper Glacier.

NELSON'S WILLOW (Salix Nelsoni)

Nelson's willow is very similar to the above but the leaves are longer and acute at both ends. It is found along Spring Creek.

Courtesy of James C. Witham

MOUNTAIN GROUSE COMING TO BREAKFAST
OF WILLOW LEAVES

WOLF'S WILLOW (Salix Wolfii)

Wolf's willow is very abundant about Swan Lake, Tower Falls, and Yellowstone Lake. It is characterized by its gray, silky leaves and short reddish catkins. In contrast with other willows and pines, it looks quite gray and is often called the Gray Willow. It is commonly only three feet high and grows in mats that cover large areas. Wolf's willow goes to the ground with only a foot of snow on account of its leaning habit. It is therefore of little use to game in winter. It is a tree of the Montane Zone not often found above Old Faithful or below Golden Gate. During the summer of 1919 when all the berries were killed by June frosts, mountain grouse lived on the leaves. In the Jackson Hole country it grows larger and forms impenetrable thickets.

(Salix pseudomonticola)

Closely allied to Wolf's willow is Salix pseudomonticola, which has green leaves with a bloom on the under surface. They are upright shrubs eight to twelve feet high. There is a graceful clump close to the steps of the Mammoth Hotel at the southeast entrance, and another about fifty feet southeast of the first one. This tree makes excellent forage and stands up well.

BLUE WILLOW (Salix subcoerulea)

Another tree growing close beside the last mentioned is Salix subcoerulea. The new growth is covered with a bluish bloom and the leaves are silvery on the under surface. Salix Geyeriana looks much like it but the leaves are pubescent on both sides. Salix subcoerulea is abundant along the Madison and its tributaries. It grows larger than either of those last mentioned.

BEBB'S WILLOW (Salix Bebbiana)

Bebb, for whom this willow is named, had a willow farm some years ago near Chicago. The tree grows large (6 to 20 ft. high) and has stiff, wide-spreading angular limbs. It

will hold up more snow than any willow in the Park. In the ravines about Mammoth it reaches eight inches in diameter and twenty feet high. The wood is stiff and strong. It lasts well in the soil like the diamond willow. The leaves are broadest toward the apex and are light colored underneath. There are a few trees at Tower Falls, Old Faithful, and Golden Gate. It becomes more abundant as we descend and makes a conspicuous part of the willow forest on the lower Yellowstone. Bebb's willow does not spread rapidly from the roots. When old trees are cut the stumps are apt to die. Its characteristic features are the long-pointed capsules and obovate leaves. It is well worth trying out as a forage tree.

GEYER'S WILLOW (Salix Geyeriana)

Geyer's willow is much like the above but has narrower leaves and bluish twigs. It is abundant at the West Entrance, Old Faithful, and the Lake. There is one clump near the east end of the porch at the Mammoth Hotel. It is also a promising forage shrub. The clump at Mammoth differs slightly from the others and is often described as Salix Geyeriana argentea.

PUSSY WILLOW (Salix Scouleriana)

This shrub has the habit of our eastern pussy willow. The catkins appear very early before the leaves. It is rare in the Park and has been collected only between Mammoth and Gardiner.

(Salix brachycarpa)

This willow is not common enough to have a common name. It is not usually over three feet high and is characterized by the densely hairy capsules and lower leaf surfaces. It has been collected at the Lower Geyser Basin, the Falls, and Soda Butte Creek.

(Salix pseudomyrsinites)

This shrub is very similar to the yellow willow but the leaves are green on both sides. It is found at Swan Lake and Tower Falls.

(Salix pyrifolia)

Salix pyrifolia differs from the above in having thin obovate leaves. This has been collected at the Lake only.

The amateur student need not feel discouraged if he finds the willows difficult to determine. Savants who have studied them for many years have the same difficulty. The staminate (male) and pistilate (female) trees are separate and as the bees and the wind carry the pollen long distances, it is difficult to recognize the parents. The distinction between tree and shrub has not been recognized in this discussion, because it has been impossible to draw the line.

SALIX PYRIFOLIA

East shore of Stephen's Island looking south.

Because of their utility to man and all wild life, they are worthy of careful study. Few trees are so lovely in form. Clumps of willows are as graceful as school girls.

In order to understand the willows and larger forests, it is necessary to view them from many standpoints. We not only observe their uses, beauty, and general appearance, but look at them by the clear, cold light of scientific study. From this standpoint, we endeavor to understand the cytology, embryology, and later growth and development. We study their morphology, histology, pathology, and echology or delve

into genetics, biochemistry, and geological history. This scientific foundation renders the superstructure more enjoyable and more intelligible.

All willows take root readily from buds of twigs over a year old. As the seeds lose their vitality in a few hours, or a few days at most, this is the usual means of propagation. Sudden rains carry bits of stem or root down the valley where they are transplanted. Like the cottonwoods, to which they are closely related, male and female trees are separate; but occasionally a single tree will bear both kinds of flowers. The pollen of all species is rough and sticks well to insects who seem to grow intoxicated over the early, fragrant nectar. While the female blossoms are dull-green and quite inconspicuous, they are sometimes as fragrant as lilacs.

All willows are subject to galls. In early summer a black fly stings the tender stems or buds and lays an egg. About this develops a conelike cluster of leaves or woody tissue which encloses the larvae. The following season, it eats its way out and is transformed into a fly, completing the life cycle.

The bible speaks of willows as emblems of both joy and sorrow, and Shakespeare connects Ophelia's tragedy with willows. To the modern student of nature, they are the emblem of adaptability, bending to every vicissitude of nature.

They are not only good friends to man, but stubborn enemies when river bottoms are to be cleared. Burning them in August and permitting them to stand a year, usually kills both root and stem, after which, the stumps rot quickly.

Willows are among the oldest plants with net-veined leaves. They were living in the Park when the first lava flows were poured out in Miocene times. As layer after layer of lava and ashes were deposited from Mt. Washburn and other ancient volcanoes, the willows rose triumphant on their cooling surfaces, doing the work of soil making and soil binding, and feeding thousands of insects and animals unknown to us.

ROCKY MOUNTAIN BIRCH (Betula fontinalis)

Growing about springs, as their Latin name implies, are dense clumps of small trees with delicate drooping twigs. Their general resemblance to the weeping birch will identify them at once, but their bark is a dark reddish-brown like cherry and speckled with ash-colored lenticals which lengthen

ROCKY MOUNTAIN BIRCH (BETULA FONTINALIS)

as the tree grows. It scales off like paper birch which distinguishes it from any other tree in the Park. At this elevation it is but a shrub, but in other parts of the Rocky Mountains it reaches eighteen inches in diameter and forty feet high. On the desert plains of Wyoming, it creeps farther

down the mountain streams than any other Montane tree. It is common from Gardiner to Mammoth, but is displaced by the Bog Birch at Golden Gate.

The blossoms, already well developed early in the previous summer, throw off their resiny coats in April, closely following the Cottonwoods. The long, drooping, staminate clusters shake their powdery dust upon the short-stalked, red-tinted, greenish scales situate in the leafy axils immediately below. The insects help, and the wind fills the air with sweet-scented pollen. The thin, broadly oval, serrate leaves appear a few days later. The under surface being pubescent, is lighter colored, and the stems are somewhat flattened. It is easily the prettiest and daintiest tree in the Park. About the hotel at Mammoth one sees it at its best, where charming clumps of filmy, deep-green foliage make restful islands of green.

The new leaves are hardly mature, till the blossoms for the following season are formed. As the old cones of the previous year are sometimes there, it is not uncommon to see three years' fruiting cones on the tree at once. The cylindric, green fruiting cone is an inch long and half as wide. It is brownish when ripe and becomes loosely chaffy, permitting the winged seeds to float away on the wind. It is easily raised from seed.

The brittle, strong, close-grained wood is not heavy, weighing 38 lbs. per cubic foot. It is very perishable in the soil. Birch makes a quick, hot fire like willow.

Birch bark tea has been used for rheumatism and the leaves for gout. The sweet sap makes wine or vinegar.

BOG BIRCH (Betula glandulosa)

At Golden Gate, Two Ocean Pass, and at many intervening elevations throughout Yellowstone National Park, is a dainty little tree only two to six feet high which resembles Rocky Mountain birch. It grows in bogs as the name implies and the bark is glandular-warty as the scientific name indicates.

The short-stemmed, roundish leaves have crenate teeth

and are only one third the size of those on the sister tree. They are deep green above and pale green below with glandular dots. The blossoms are similar to those of Rocky Mountain birch, but they come in summer.

Bog birch is found in the cold swamps of Colorado and on the tundras of Alaska and Asia. Maine, Michigan, and Minnesota are other locations of this picturesque tree.

The spicy bark is as pleasant to the taste as wintergreen. The whole tree has a pleasing individuality which every nature-lover will appreciate.

Both the birches date their ancestry back to the Dakota sandstones of Cretaceous times.

TAG ALDER (Alnus tenuifolia)

Hanging over ponds and streams like a vain waternymph, is the Alder. It is a low, round-topped tree with smooth, gray bark. Along Tower Creek, the Gardiner, and Yellowstone rivers it is a shrub from one to eight inches in diameter and twenty-five feet high, growing singly or in large groups. There is an unusually fine group at the head of the irrigation ditch about two miles above Gardiner. They thrive throughout the Rocky Mountains from Alaska to California.

Alder is the earliest spring blossom, shaking down its powdery, purplish curls in March or April fully ten days before the willows and aspens. The pistilate flowers are inconspicuous little groups of greenish scales situated close below the staminate flowers on the same branch. After the winds and the insects have fertilized them, the staminate catkins fall and the shining, deep-green leaves appear. They have no scale-buds but have been wrapped in the stipules. The magenta-colored twigs and leafstems are almost smooth. The thin, cordate, doubly-serrate leaves are acute at the tip with prominent yellowish veins beneath. Lining the shoes with them makes an excellent foot-ease. The leaves are thin, as their Latin name "tenuifolia" implies. In autumn they turn brown, adding but little to the forest colors.

Through the summer the pistilate scales develop into a

green cone an inch long. But before this is completed the new blossoms for the following season are well formed. As the old, brown, woody cones remain a year after the seed has fallen, there are thus three years' fruit bodies on the tree at once, which is confusing to the amateur. The old, dark-colored cones give it the appearance of mulberry, as one passes rapidly in the car. The seeds fall in August, sailing several feet away on their margined wings. Alder is easily propogated from seed.

The astringent bark turns red at once after being peeled. Pioneers use it for making ink, dyeing cloth, and tanning robes. A tea made from the bark was used as a tonic and to apply externally to erysipelas. A charred alder stick makes a much clearer line than carpenter's chalk. Its charcoal is best for gunpowder.

Alder endures shade, making a thick second-growth under cottonwood where the water table comes close to the surface. The wood is soft and light, weighing 30 lbs. per cubic foot. It makes durable fence stays, but rots in the soil the third year. The timber is straight-grained with a white sap and a brown heart. It makes a clean, quick fire like cottonwood. When cut in winter, alder sends up a fresh supply of branches from the stump. Trees cut in August rarely sprout. The stumps rot the third year and the land can soon be cultivated.

There are fifteen species of alder in North America, two of which (Alnus tenuifolia and Alnus sinuata) grow in the Park.

MOUNTAIN ALDER (Alnus sinuata)

Mountain alder is a smaller shrub with greener leaves, rounder cones, and grows about mountain springs at higher elevations than the other.

Alder is not a long-lived tree with us. Fifty rings are sometimes counted, but usually borers have attacked its soft wood before that time. It is full of holes made by flickers and woodpeckers in grubbing out insects. They frequently hollow it out for nests. One must not imagine that the woodpecker is pounding just for fun. He is more often grubbing

out some insect or its eggs, picking them deftly out of the holes with his long, spear-like tongue. The Biological Survey estimates that the birds destroy 100,000 bushels of insects each year. While the birds do some harm, it is only fair to balance the ledger.

Alder is used by the beaver. They seldom touch pine, but in 1919 three small lodgepoles were cut, probably by some inexperienced youth. They used no part of it. Alder, willow, and birch are all friends of the trout, harboring the insects on which they feed. Moreover they keep the amateur fisherman busy untangling his line, while the fish feed undisturbed by his vociferous opinions.

Thirty species of alder are described from the Eocene Rocks.

OREGON GRAPE (Berberis aquifolium)

The waxy, shining, prickly-leaved, evergreen shrub, resembling dwarf holly, is Oregon Grape. In Yellowstone Park it is seldom over eighteen inches high and usually but five inches. In Oregon there are varieties reaching ten feet. The waxy, yellow, sweet-scented flower clusters appear in May and June down in the axils of the leaves. The green fruit appears like a miniature bunch of Concord grapes. In August and September they turn blue with a fine bloom like plums. The grapes are as sour as a lemon until they are touched with frost. They make excellent jam or jelly.

A tea made from the root was used by the Indians to allay fevers and to stimulate the kidneys. Oregon grape grows in the Rockies from Arizona to British Columbia. It is one of the few shrubs that thrive under pine. Early in autumn, the leaves turn a brilliant red, making a gay pattern on the rather somber carpet of pine needles. It is very abundant on open slopes above Mammoth Hot Springs and is frequently met along the edge of the timber throughout the Montane Zone.

POISON OAK OR POISON IVY (Rhus Rydbergii)

Poison ivy in the Park is a little, upright shrub less than four inches high. It is very rare and has been collected only between Gardiner and the Golden Gate. The leaves are not leathery like Oregon grape, but they grow in threes and are highly colored, which makes it possible for the amateur to mistake it for that shrub.

It is the juice only which is poisonous. The gray, ripe fruit is about as large as tame currants. Birds eat it with impunity.

Instances of poisoning without coming in contact with the plant are probably erroneous, but one may be poisoned by handling articles which have bruised the plant, like shoes or walking sticks. Poisoning is most apt to occur in the spring, when the plants are juicy and easily bruised. One is most susceptible to poisoning when perspiring. It is a good plan to change the clothing and shoes after walking through ivy and to wash the exposed parts of the body thoroughly to remove the poison juices. Dry plants are not poisonous. As scratching only spreads the irritation, a bandage with some cooling lotion is advantageous.

SONORAN SHRUBS

When deep snows drive the grazing and browsing animals to the lowlands between Mammoth and Gardiner, there are several inconspicuous shrubs which help to maintain them. They grow on hillsides and bare knolls where the wind sweeps the snow away and they are thus available for food.

WINTER FAT (Eurotia lanata)

Winter fat is a sprawling shrub of bare, saline ridges and flats. It would ordinarily be a foot high, but the deer and elk keep it browsed to the ground. The linear, lanceolate, silvery leaves are turned under on the edges and are covered with stellate hairs. The inconspicuous flowers, in axilary spikes or clusters, have a four-parted calyx. Sometimes the staminate and pistilate flowers are on the same shrub, and

again on separate bushes. The seeds look like a handful of wool lying on the ground and are the most conspicuous thing about it. In eastern Wyoming it is highly valued as winter grazing for sheep. It makes less than one per cent of the shrubby covering between Mammoth and Gardiner.

SALT SAGE (Atriplex Nuttallii)

In the same region, we find salt sage, readily distinguished by its salty leaves. Ordinarily it is from one to two feet high, but, like winter fat, is browsed to the ground. The greenish, inconspicuous flowers are in spikes at the ends of the branches or in the axils of the scurfy, oblanceolate leaves. Salt sage sheds its leaves early, but stock and grazing animals seek them out as they would grain. They contain less nitrogen and more protein than the grasses.

GREASEWOOD (Sarcobatus vermiculatus)

Greasewood is an erect, widely-spreading, spiny shrub from two to eight feet high. The staminate, greenish, inconspicuous flowers are at the ends of twigs. The pistilate, on the same or separate shrubs, can hardly be seen without a lens. They grow in the axils of the fleshy narrow leaves. The light-gray to white stems are usually covered with lichens. The seeds are more conspicuous than the flowers, as they have broad, thin wings which are often tinted with red. The shrub is too spiny for the browsing animals. It is an indication of heavy, saline soil. Sarcobatus comes from two Greek words "flesh-thorn" which is a good description of the stems and leaves. It burns fiercely with a sputtering noise like grease, which likely accounts for the common name. It is found between Mammoth and Gardiner and does not ascend to the Montane Zone.

HOP SAGE (Grayia spinosa)

Another spiny shrub of this section is Grayia, named for Asa Gray, the great botanist. It has mealy, spatulate leaves and greenish, inconspicuous flowers in axilary and terminal

spikes. The fruiting bodies have pink and white orbicular wings half the diameter of a penny and are very noticeable in autumn. Game do not browse it. It is not related to sage, but the large, winged seeds somewhat resemble hops. It grows on heavy, alkaline plains and makes less than one per cent of the shrubby covering between Mammoth and Gardiner.

SKUNK-BUSH (Rhus trilobata)

Skunk-bush is a spreading, stiff, angular shrub from two to six feet high with small, yellow blossoms and oval, lens-shaped, rank-smelling seeds. The small, sweet-scented blossoms come in May. They do not have the strong odor of the wood and leaves, and are sought by bees and all lovers of fragrance. In early spring, the dense clumps take on a magenta color which quite alters the color of brushy slopes. The branches are wide-spreading, stiff, and hard to penetrate. The yellow roots are deep-set like sage and stop the plow with a jerk. These hard-headed ways and the turpentine odor deprive it of many friends. If some one would make an offer to cut out all the skunk-bush in the Park we might be inclined to accept it. But who is it in autumn that paints the hillsides so gay? Who could believe that plain old Skunk-bush that we have been turning up our noses at all summer would dress up like a prince to bid his unfriendly friends good-by? Dramatic, isn't it? Bees would vote to retain it. Birds that nest there and rabbits that hide there would vote for skunk-bush. Man would wonder why the hillsides were so desolate. In our national parks we may step out of our egocentric circle and look at nature from the standpoint of wild life.

The scientific name is far more accurate than the common one. Rhus, in Greek, Latin, and Celtic, means ruddy or red, which is true of the new leaves, the stems, the berries, and the autumnal foliage. It does not have the odor of polecat. Rhus trilobata is closely related to poison oak, but is not at all poisonous.

It is browsed only by starving animals. In the Park it is found only in the vicinity of Gardiner, but further down the Yellowstone the hillsides are covered with it.

SHRUBBY PHLOX (Leptodactylon pungens)

Leptodactylon is only a few inches high. The narrow, prickly leaves are in tufts close to the stem. The sweet-smelling blossoms remind one of wild phlox. It is not necessary to request the tourist not to pick it. Leptodactylon pungens can take care of itself. It is found on dry hillsides about Tower Falls and Mammoth. The odor is delightful.

This limited area of only a few square miles, with heavy, alkaline soil and a plant life like that of arid Wyoming, is a problem for the echologist. From its elevation, between five and six thousand feet, it would normally lie in the Montane Zone on the north side of the mountains. To the ordinary tourist it is uninteresting. For the thoughtful student the country between Gardiner (5,287 ft.) and Swan Lake (7,800 ft.) is one to be walked over many times. The journey from the Canyon Hotel (7,600 ft.) to the top of Mt. Washburn (10,000 ft.) is also well worth the time for travel on foot if one is to understand it. The changes in both plant and animal life are too manifold and profound to be noted from a rapidly moving car.

SILVER BERRY (Elaeagnus argentea)

One of the most striking shrubs in regard to color is silver berry. The twigs, leaves, and berries are a silver white. The clusters of very small, yellow flowers are deliciously fragrant. It is only the inside of the flower that is yellow. The outside is like the leaves, silver-colored. It grows from eight to twenty feet high and is seldom upright. It makes a silver border to the Gardiner River a short distance above Gardiner, and is not found above Mammoth.

RABBIT BRUSH (Chrysothamnus)

Rabbit brush grows only one or two feet high on the arid slopes about Mammoth Hot Springs and Gardiner. It has a thick, bushy top with yellow flowers in a dense cluster and makes a good hiding-place for the bunnies. The form with green stems and smooth, three-nerved leaves is Chrysothamnus pumilus. The form with white-woolly stems and a very pungent odor is Chrysothamnus nauseosus. The flowers are very showy in August.

(Tetradymia inermis)

Tetradymia inermis is a low, rigid shrub like white sage, with compact terminal clusters of yellow flowers which bloom in August. The annual growth and the leaves are clothed with short, dense, white wool. It strongly resembles white sage when not in bloom, but the leaves do not have the sage flavor. It also resembles rabbit brush but has only four flowers in a head while the latter has five or more. It is found on dry hills about Gardiner, Tower Falls and Mammoth, and is not abundant.

These plants of the lower Yellowstone and Gardiner rivers have been described somewhat out of their natural sequence because of their common location. They make less than one per cent of the total shrubbery of the Park; they occupy a very limited area and would hardly be noticed from a moving car. In seeing it for the first time, we conclude that there is nothing of interest here, but on careful study it becomes one of the most interesting botanical regions in the Park.

PURPLE VIRGINIA BOWER (Clematis occidentalis)

Virginia Bower is a woody vine, usually about five feet high, which grows in thick tangles of other shrubs. The ovate, accuminate leaves are in threes and the violet-to-purple, showy flowers have four sepals. Old flowers fade to white. It is found in the hills above Mammoth, but is nowhere

abundant. The flowers are two to three inches in diameter, including the spreading sepals, which makes them very conspicuous. White Virginia Bower (Clematis ligusticifolia), with masses of white flowers, is occasionally found in the same location.

GOOSEBERRIES AND CURRANTS

KEY TO THE GOOSEBERRIES AND CURRANTS (Ribes)

Stems usually prickly.
- Flowers tubular, 1-4 flowered;
  - Spines solitary,
    - Fruit smooth,
      - Stamens equaling the sepals ..... Ribes saxosum
      - Stamens twice as long as the sepals ..... Ribes inermie
    - Fruit hispid ..... Ribes setosum
  - Spines triple, long ..... Ribes saximontanum
- Flowers salverform, several flowered;
  - Fruit black, leaves glabrous.
    - Leaf lobes acute,
      - Spines and bristles of the same length.... Ribes lacustre
      - Spines much longer than the bristles.... Ribes echinatum
    - Leaf lobes obtuse ..... Ribes parvulum
  - Fruit red, leaves pubescent ..... Ribes montigenum

Stems not prickly.
- Fruit sticky.
  - Fruit black and bitter ..... Ribes viscosissimum
  - Fruit red and spicy ..... Ribes cereum
- Fruit smooth, or resin-dotted,
  - Flower clusters erect ..... Ribes Hudsonianum
  - Flower clusters drooping ..... Ribes Americanum

WESTERN GOOSEBERRY (Ribes saxosum)

Ribes saxosum is usually very spiny, with white or greenish-white flowers. It is common on the lower Yellowstone about Mammoth and Blacktail Deer Creek. The leaves are somewhat pubescent and glandular. The smooth, dark purple berries are often over a quarter of an inch in diameter.

UNARMED GOOSEBERRY (Ribes inerme)

This gooseberry resembles the above, but has glabrous, shining leaves and red-purple fruit. It has been collected at

Mammoth, Golden Gate, Tower Falls, and the lower courses of Slough Creek.

ROCKY MOUNTAIN GOOSEBERRY

The Rocky Mountain gooseberry has triple spines from one fourth to one half an inch long with finer prickles between. The flowers are white, tinged with violet. The smooth berry is reddish-purple. It is found at Mammoth and Tower Falls.

PRICKLY GOOSEBERRY (Ribes setosum)

Ribes setosum is characterized by its rough berry which varies in color from red to black. It is quite abundant about Mammoth.

All the above gooseberries are early bloomers. They make pretty, drooping clumps on open hillsides and about rocks. The old wood is frequently smooth. It is not uncommon to find half the shrub very prickly and the other half without spines. They are thus difficult to identify by spines. Deer are very fond of young gooseberry leaves and not infrequently get the spines in their noses. It is a pretty sight to see them bring the hind foot forward and rub them out as daintily as a lady would remove a rose thorn from her finger. The green fruit on all is very sour, but fully ripe berries have a pleasant, mild, acid taste which is very agreeable. It will be noticed, also, that they are shrubs of the lower elevations. The clumps vary in size from two feet to eight feet high. They are one of the first shrubs to put out leaves in early spring.

The four following species are called the swamp gooseberries because of their habitat. They are intermediate forms between gooseberries and currants. The fruit and prickly stems resemble small gooseberries, but the blossoms and fruit are in clusters like currants.

SWAMP GOOSEBERRY (Ribes lacustre)

Ribes lacustris has four to ten light green to purplish flowers, smooth leaves, very prickly stems, and small, black, rough fruit. It has been collected at Tower Falls.

SPINY GOOSEBERRY (Ribes echinatum)

Ribes echinatum has six to twenty purplish flowers with long spines near the leaf bases and shorter ones along the stem. The berry is larger than the above and almost smooth. It grows at the Upper Falls and along Soda Butte Creek.

LITTLE GOOSEBERRY (Ribes parvulum)

Ribes parvulum has four to eight purplish flowers and the stems vary from very prickly to smooth. It is the most abundant and the sourest gooseberry in the Park. The fruit varies from the size of large currants to that of gooseberries. It is found along brooks, about grassy swales, and borders lodgepole forests throughout the Montane Zone.

MOUNTAIN GOOSEBERRY (Ribes montigenum)

Ribes montingenum is a broadly spreading shrub seldom over two feet high. It grows at higher elevations than the above, but there are a few bushes at Golden Gate and Old Faithful. It is quite abundant along Spring Creek.

STICKY CURRANT (Ribes viscossimum)

The sticky currant has large, cream-colored or white flowers, very sticky stems which are often covered with fragments of other plants, and sticky, intensely bitter fruit. The ovate fruit is green during the tourist season and turns black late in the fall. Old stems are not viscid and have a reddish, shreddy bark. It is a stiff little shrub which grows from eight inches to two feet high. It is abundant on dry hills in thin timber about Golden Gate, Mammoth, and Tower Falls.

SQUAW CURRANT (Ribes cereum)

The squaw currant grows only on rocky rims about Gardiner. It is a stiff, angular shrub with pink or greenish-white flowers, and red currants. The wood and leaves have a pleasant odor and the flowers are delightfully sweet. The spicy, sticky currants do not please the white palate. Further down the Yellowstone it is very abundant.

HUDSON'S CURRANT (Ribes Hudsonianum)

Ribes Hudsonianum is an erect shrub from two to five feet high, with erect clusters of white flowers and resin-dotted leaves and currants. It has been collected only between Mammoth and Golden Gate.

AMERICAN CURRANT (Ribes Americanum)

The American currant differs from the above in having drooping flower clusters. I have not discovered it, but Parry reports it on Slough Creek.

All the five-leaved pines are now threatened by a parasitic fungus (the white pine blister rust) which has its alternating generation on gooseberries and currants. Many fine forests of the East and Pacific West have already been destroyed. The rust goes alternately from shrub to pine, but will die if either is exterminated. Thus far, it has not invaded the Park. The trees, shrubs, flowers, and animals are so closely associated that we cannot understand one without studying all.

The graceful, drooping stems of gooseberries and currants, covered with fragrant blossoms and later with fruit, add much to the beauty and interest of the Park. A delightful thing about our western mountains is the wild fruit—gooseberries, currants, service berries, huckleberries, strawberries, salmon berries, red raspberries, and elderberries; all found abundantly in Yellowstone National Park. A bear eating berries is a picture of solid satisfaction. No dainty

picking for him. He spreads out over the bushes like a lazy cat, stripping berries, leaves, and twigs with an upward movement of the jaws, using the paws deftly to gather in stray branches. He cannot do this with gooseberries and often passes them by. The bitter bearberries (Shepherdia canadensis) are especially pleasing to him.

WHITE DRYAD (Dryas octopetala)

WHITE DRYAD (DRYAS OCTOPETALA) AT TIMBERLINE
Stunted Engelmann Spruce and Alpine Fir in the background.

As we look at the summits of Mt. Holmes, Electric Peak, and the Beartooth Mountains from the lowlands, they seem

bleak and uninteresting. What a pleasant surprise it is on ascending to find that they are hanging gardens which rival one of the seven wonders of the world. Even the bare-looking rocks are covered with lichens of all shades, and the bits of soil between are miniature flower gardens.

Just above timberline there are large areas of white dryad carpeting the soil and creeping over the rocks. The thick, oblong, green leaves make a beautiful setting for the large white flowers. They blossom a few days after the coverlet of snow is removed, usually in July, and the flowers wither quickly. The shrubby, creeping stems remain throughout the season and are browsed with great relish by mountain sheep. There are thousands of acres in the Beartooth mountains carpeted by this beautiful shrub.

SPIRAEA (Spiraea lucida)

Spirea is a tender shrub which sometimes freezes down in winter. It is only a foot high with a white, flat-topped cluster of sweetsmelling flowers from three to five inches in diameter. The oval leaves have a few notches near the apex and grow larger on the upper part of the stem. It is scattered through the Montane Zone in open parks and along the edges of the forest.

RED RASPBERRY (Rubus strigosus)

Red raspberry is very common through the Montane Zone and climbs to the lower Hudsonian. The small, white or purplish flowers, the prickly stems, and red berries readily distinguish it from the salmon berry. The fruit is like that of tame raspberries, but a little more tart and finer flavored. Its favorite location is among slide rock and old boulder moraines. Bears, birds, and tourists enjoy the delicious berries. Thrifty pioneer housewives use them fresh or preserve them for winter.

SALMON BERRY (Rubacer parviflorum)

Salmon berry has leaves from five to nine inches in diameter, smooth stems one or two feet high, and beautiful,

white flowers as large as apple blossoms. It grows in moister locations than red raspberry and has a larger, flatter, more insipid berry. Its usual habitat is about springs and moist places in the shade. There are fine specimens at Golden Gate, along Soda Butte Creek, and in many places throughout the Montane Zone. It is not so abundant as red raspberry. Not often do we find enough for supper. Ripe berries are salmon-colored.

NINE-BARK (Physocarpus monogynus)

Nine-bark grows about three feet high along the road from Tower Falls to Gardiner. It has small, flat-topped terminal clusters of white or pinkish flowers. The three-lobed leaves are again lobed between, and the flowers have a five cleft calyx and five petals. It is one of the first shrubs to show fire in later August. Further down the Yellowstone it is very abundant on dry hills and adds much to the autumnal coloring.

YELLOW ROCK ROSE (Dasiophora fruticosa)

There are two shrubs in Yellowstone Park which are not afraid of geysers. They creep out on the hot formations and even look into the boiling springs. Yellow rock rose is a spreading shrub from one to four feet high with single yellow roses about one fourth as large as the tame ones. They are not roses, strictly speaking, and do not have the rose odor or taste. Where we leave the main road to go to Firehole Lake there are acres of them. Little shrubs only three inches high climb nearly to the top of Mt. Washburn. They cling to the dripping rocks overlooking Gibbon Falls. They grow on arid points and in swamps. On the plains of Iowa they are called Prairie Weed and among the boulders of Maine, Hardhack. They are deep-rooted and stop the plow with a jerk. We find them also in northern Europe and Asia. They encircle the globe.

The blossoming period lasts all summer. In adaptability, yellow rock rose rivals any shrub or tree in the Park. It

has no economic value, but we may remember the words of Cowper: "No tree in all the grove but hath its charms."

GOLDEN ASTERS (Chrysopsis)

Golden asters, like street gamins, look quite uninteresting till one learns to like them. They are from a few inches to two feet high, with grayish leaves and ragged, yellow flowers. Specialists make three species. Chrysopsis hispida has short, somewhat appressed hairs on stems and leaves. Chrysopsis villosa has coarser, longer pubescence. Chrysopsis depressa is a low form growing on the geyser formations. The ripe flowers have a pappus, like dandelions, to scatter the seeds, while yellow roses do not. They venture out on the hot geyser areas, but do not climb the mountains.

WILD ROSES (Rosa)

It is with the greatest trepidation that I write of the wild roses. They are under the protection of powerful fairies and one never knows what his reward or punishment may be for meddling with them. Many a man has thoughtlessly given away a wild rose and has not been able to speak a sensible word for weeks after. Black tresses and red roses, blond hair and pink roses are especially dangerous combinations. Widows and roses! Let the man who makes this combination suffer the consequences! If a child wishes to know how Mother looked as a girl, give her a wild rose. For just an instant the fairies will change her back. A few roses to hide the medicine bottles in the hospital will always help the patient's recovery.

There are two roses in Yellowstone Park. One (Rosa Bourgeauiana) has smooth stems and doubly serrate leaves. The other (Rosa Spaldingii) has very thorny stems and simple-toothed leaves. Both are very abundant and indescribably beautiful, as roses always are. They climb Mt. Washburn to the 8,500 ft. levels.

For each season they offer beautiful gifts. In spring, the new leaves are almost as fragrant as the flowers and the

buds and twigs are as pink as the flowers they promise. In summer, there are the odorous blossoms, and in autumn the scarlet berries are almost as pleasing. Each shrub has a different flavored berry just as wild apples have. The Indians gathered them to mix with buffalo tallow in making pemmican and even the old saddle horse nibbles the sweet twigs and berries in spite of the thorns. Browsing animals and birds pick every one that is not hidden under the snow.

Roses, like thorns and wild apples, have great individuality. It is impossible to classify them satisfactorily. Whether one makes a few species or many, there are individual roses that do not fit. Luckily, we do not need to classify them to enjoy them. With or without names, they will always be free lances, emblems of romantic love.

SERVICE BERRY (Amelanchier alnifolia)

Service berry is cosmopolitan throughout the West to the constant joy of boys, bears, and birds. It is a shrub with smooth, gray bark, from one to ten feet high. The snow-white blossoms appear early before the leaves and completely cover the trees. The fruit is green till August and then the color of Concord grapes.

Like wild apple and thorn trees, no two bushes seem to have exactly the same flavored fruit. They vary from bitter and dry to sweet and juicy. No mountain fruit comes so near making a satisfactory meal for a hungry man. The method of fruiting varies also. Some berries grow singly, others are in terminal clusters, while again the fruit is like that of currants. The size varies from that of a small currant to that of a grape. They are rather insipid when canned unless cooked with raspberries or gooseberries with which they grow and ripen. The pioneer housewife stocked her cellar with them and the Indians gathered them for drying and for pemmican.

With us, they thrive from the 2,000 ft. levels of the plains to the 7,000 ft. parks in the mountains, extending from Alaska to California, and east to Lake Superior. June berry

is a common name further east. There is a fine clump just above the Mud Geyser which always seems to bear fruit, protected no doubt by the steam from frosts that often ruin the entire crop. "Amelanchier" is the old Savoyan name given by Linnæus, the founder of systematic botany, and "alnifolia" refers to its alder-like leaves. Sarvice-berry is only a corruption of its proper common name.

All the browsing animals like the leaves and twigs. Bears strip leaves, berries, and all in great mouthfuls.

It is the heaviest wood in Yellowstone Park, weighing 49 lbs. per cubic foot, or twice as much as pine. Its fuel value does not correspond to its weight. Chokecherry makes a better campfire. The Indians used the straightest shoots for arrows, tying them straight in presses. The eastern form, called lancewood, is used for fishpoles in place of bamboo.

In autumn the tree shows pale reds, browns, yellows, all the apple orchard tints. The fruit tastes like summer apples and has their delicious odor.

DWARF SERVICE BERRY (Amelanchier pumila)

The dwarf service berry grows on dry, open hillsides above Mammoth Hot Springs with Douglas fir. It is similar to its larger sister, but grows only three feet high.

PURSHIA (Purshia tridentata)

In so far as we have observed, Purshia tridentata comes into the Park only at the West Entrance. The roadside for a few miles is well lined with it.

It is a rather stiff shrub from three to six feet high which grows along the edge of the timber on dry soil. The leaves are wedge-shaped with three teeth at the apex which accounts for its specific name. It was named for a distinguished plant lover, Frederick Pursh, who died a century ago. The yellow flowers are small, funnel-form, very fragrant, and have twenty-five stamens.

MOUNTAIN ASH (Sorbus scopulina)

Mountain ash is a stout shrub from four to ten feet high. The smooth leaves are about six inches long with eleven to fifteen serrate leaflets. The white flowers grow in flat-topped clusters like elderberries. The red fruit is a little larger than service berries and very bitter. It is not abundant anywhere in the Park, but there are scattering bushes along the edge of the timber at Old Faithful, along the Yellowstone below the lake, along the Gibbon River, and at many other places. Everyone who knows mountain ash as an ornamental shrub will recognize it.

CHOKE CHERRY OR ROCKY MOUNTAIN CHERRY (Prunus melanocarpa)

Growing everywhere on a great variety of soils, with rose and service berry, is the Rocky Mountain cherry, or choke-cherry. On the lower Yellowstone it is sometimes a foot in diameter and thirty feet high, but in the higher altitude of Yellowstone Park it is a dwarf shrub, the largest of which are an inch in diameter and ten feet high.

It spreads by roots as well as by seeds, making dense clumps. The roots are large and strong, stopping the plow with a jerk. Repeated browsing and burning often leave a large root while the stem may be but a few years old. The Indians carved these heavy roots into ladles, leaving the slender, stiff stems for handles.

In May, when the leaves are half grown, the blossoms appear, filling the whole region with a delicious, wholesome, cherry odor. The snow-white petals and dark stamens produce a very decided salt-and-pepper effect. The waxy, shining leaves are almost as fragrant. They have a pleasant, bitter taste, like green tea leaves. It would be dangerous, however, to drink strong cherry tea or to swallow many of the crushed fruit pits, as they contain prussic acid. Cattle and horses are sometimes poisoned by eating them exclusively when other forage is scarce.

The cherry clusters are dark green in June, red in July, and black in August, as their scientific name, "melanocarpa," describes them. After light frosts, they lose much of the puckery taste so pronounced when green. At no time are they as astringent as eastern chokecherries from which they are quite distinct. As soon as the fruit begins to turn, birds, bears, and children begin feasting on the fruit. The thrifty housewife puts the stewed berries through a colander to remove the stones, making a delicious jam, or mixes them with buffalo berries for jelly. It is too rich to be eaten often or in large quantities and apples are often added. The Indians dried the berries, pounded them fine, pits and all, in a stone mortar, and mixed them with buffalo tallow and dried meat. If cherries were scarce, rose berries or service berries were used. This made the delicious pemmican, so highly prized by the trappers and scouts on account of its portability and keeping qualities. It was very nutritious and made a balanced ration. The Indians also used the astringent berries to stop bleeding, and a tea made from the leaves as a diarrhea remedy.

The seeds are not injured by passing through the alimentary canal. Birds regurgitate them. In these ways they become widely scattered. It is a very common shrub in the Rocky Mountains between Arizona and British Columbia. It is not a long-lived tree, but is very tenacious of life, sending up a liberal supply of suckers if cut or burned. Burning in August and allowing the old stumps to stand, kills root and branch. Black-knot (dibotrion morbosum) is its worst enemy. It is easily controlled by cutting off the infected branches.

The wood is heavy, weighing 43 lbs. per cubic foot. It is hard like maple and stiff like ironwood. Like these woods, it is not durable in the soil. It makes a clean, hot campfire with a good bed of coals.

It is a very satisfactory ornamental shrub, contributing something beautiful to each season. In a modest way, it is to the western landscape what the hard maple is to the East, giving the most fiery autumnal colors. Yellowstone Park, with its average altitude of 8,000 feet, is too high for it

to make a large development, but along the lower Yellowstone its flaming red autumn foliage makes beautiful contrasts with the yellow of cottonwood, willow, and aspen.

MOUNTAIN MAPLE (Acer glabrum)

Among the rocks of the lower mountain slopes, with service berry and rose, is the mountain maple. Sometimes it grows with the willows and alders along streamlets, or it may cover cool, north slopes with an exclusive forest of maple. "Acer," in Celtic, means hard, and "glabrum" refers to the smooth, gray bark which is even lighter colored than hard maple. In deep, rich soil about Mammoth Hot Springs it makes clumps of small trees from one to four inches in diameter and twenty feet high. There are records of trees a foot in diameter and thirty feet high in other locations.

The blossoms appear with the leaves in May. The female flowers are at the base, and the male at the apex of the long-stemmed flower clusters. The petals and sepals are of equal length and the stamens vary from four to nine. The leaves resemble small maple leaves but vary greatly. Some are nearly entire, while others are divided almost to the base. The sap is sweet and abundant as in sugar maple. Insects are always found hovering about it. The black-tail deer often steps out of the trail to snatch a mouthful of the bitter-sweet leaves. All kinds of domestic stock browse its nourishing leaves and tender shoots.

The seeds, in pairs till September, become separated then, falling to the ground with a fluttering motion like some disabled insect. The wind carries them aside about the width of the tree. Mice, squirrels, and birds feed on them, carrying them further. Mountain streams wash them about and bury them, so there is no lack of distributing agents.

The hard, light-brown wood tinged with red weighs 37 lbs. per cubic foot. It is excellent firewood if one is heartless enough to cut so beautiful a shrub. The dead wood makes a pleasant campfire. It is not durable in the soil.

Mountain maple has a dashing school-girl color that is always refreshing. In winter, its buds and twigs are a deep red, turning fiery in the early spring sunshine. The leaf stems are always pink and the young leaves are covered with bright red galls which give the tree a gay appearance. In September it has all the brilliance of hard maple.

"Earth's crammed with heaven,
And every common bush afire with God.
But only he who sees it takes off his shoes."

It is a Rocky Mountain tree, growing from Arizona to British Columbia.

Mountain maple is quite abundant in the Park in the Transition and lower Montane Zones, but it never ascends into the Hudsonian. In the higher altitudes it grows in clumps like birch. Lower down, there are separate trees. As a rule, however, we find it in cæspitose clusters. It descends the Yellowstone as far as Columbus where it is found on north slopes at 4,300 ft. elevation.

MOUNTAIN BALM (Ceanothus velutinus)

Mountain balm is common throughout the lodgepole pine belt. It quickly takes possession of burned areas, but as the new forest thickens, it dies away. Bare ridges and open mountainsides are white with its large lilac-like clusters in June. In July and August the green clusters of three-lobed berries are conspicuous. The oval, dark-green, leathery leaves gleam in the sunlight as if they were waxed.

Mountain balm makes dense thickets. While it is only two or three feet high, the half prostrate tangles are very slippery and difficult to penetrate. Mountain laurel, snow bush, chaparral, and New Jersey tea are other common names. It was the sister shrub (Ceanothus americanus) which was used in Revolutionary times as a substitute for tea. It is abundant along the roadside between Mammoth and Golden Gate. Its fragrance accounts for the common name.

BUCKTHORN (Rhamnus alnifolia)

This is not a thorny shrub as its name might suggest. Parry reports it in the Park on the East Fork of the Yellowstone (Lamar River) but I have been unable to find it. Rhamnus is quite common in the Main Range and the Bitter Root Mountains further west. It is an upright shrub with conspicuously veined, ovate, sharp-pointed leaves. The flowers are greenish and the black fruit about as large as service berries. It seldom exceeds six feet in height in our section.

BEAR BERRY (Shepherdia canadensis)

Bearberry is one of the few shrubs that thrive under lodgepole pine. The stems, leaves, and flowers are covered with rust-colored flakes. The small, greenish flowers grow close to the stem. The red or yellow berries make the woods quite gay in autumn. Bears and birds are fond of them although they are extremely bitter. It is from two to five feet high and grows in small clumps.

RED WILLOW (Cornus stolonifera)

In the clumps of shrubbery about the hotel at Mammoth, and along the lower courses of streams, is the red willow, named from its maroon-colored stems. It is only two to nine feet high and less than an inch in diameter. It spreads by runners as its scientific name "stolonifera" indicates. Red willow makes rather loose clumps, the individual shoots of which squat indolently on their heels. Further down the valley at 3,500 ft. it is much larger. It is not a willow, properly speaking, but belongs to the dogwood family. Its habit of growth doubtless gave it the common name.

The ovate, pointed, smooth-edged leaves are yellowish-green or olive-green above, but appear quite gray when the wind turns them over. In May, the white, sweet-scented clusters of flowers appear on the ends of the branches, resembling diminutive clusters of elderberry blossoms. Each individual blossom has four petals and four sepals. Through June and July, the berries are greenish. In ripening, the follow-

ing month, they turn a lead-white. The berries attain the size of small peas and contain a very irregularly shaped stone. The fruit is not palatable, but birds eat it freely and help to distribute the seeds.

The wood is rather tough like willow. Its generic name "Cornus" is from the Greek, meaning "hard," which refers to the quality of the wood. The Indians scraped the bark into fine shreds and smoked it in their peace-pipes, mixing it with tobacco when they could obtain it.

In autumn the leaves pass through many beautiful shades from green to dark red, making great stretches of color which are reflected in the still waters of the lakes and ponds where it abounds, and contrasting beautifully with the lighter red of the roses and the yellow of the willows. In winter, its stems are the brightest color in nature, vying with the sunset in brilliancy. In spring, it turns a fiery red as if blushing under the amourous glances of the Sungod. Like the Kentucky cardinal, its color holds one spellbound. Red willow grows along the foothills of the Rockies and about the Great Lakes. It is very popular in parks and lawns, giving a touch of life to the somber winter landscape.

LABRADOR TEA (Ledum glandulosum)

Labrador tea is a low shrub about one foot high, with smooth leaves which are lighter colored on the under side and dotted with resin. It is difficult to distinguish from American laurel. The petals are white and not united, while in laurel they are usually purplish and always united at the base. The leaves of laurel are opposite, those of ledum are alternate. Both grow in cold swamps of the Hudsonian Zone, but this has been collected as far down the Yellowstone as Boiling River. The leaves are sometimes used as a substitute for tea.

AMERICAN LAUREL (Kalmia polifolia)

American laurel is an evergreen shrub, rarely over eighteen inches high, which grows in cold springs or subalpine

bogs. The leaves are turned under on the edges and much whitened beneath. The waxy, lilac-purple, saucer-shaped flowers are very beautiful. The leaves often harbor the spores of a parasitic fungus (Peridermium coloradense) which has its alternating generation on Engelmann spruce. It grows along Spring Creek and the swamps above that elevation.

MOUNTAIN HEATH (Phyllodoce empetriformis)

Mountain Heath reminds one of Scotch heather. It is an evergreen shrub growing in dense patches and has the appearance of stunted spruce or fir. It is only one or two feet high, but the masses of red flowers make it one of the striking shrubs of the Park. There are a few at the Upper Falls and a good stand at the Daisy Pass near the trail to Grasshopper Glacier.

BLUE BERRY (Vaccinium)

Three kinds of blueberries, or huckleberries, are very abundant in Yellowstone Park.

GROUSE BERRY (Vaccinium scoparium)

Grouse berries grow on spreading bushes only a few inches high. They make beautiful, green carpets, completely covering many square miles between Old Faithful and the Thumb. The red or black berries are too small to pick for table use, but they are fine flavored if one has the patience. They grow well under the pines, firs, and spruces, but are not so fruitful there as along the edge of the forest. They reach their maximum development between 7,500 and 9,000 feet. It is easily the most abundant shrub in the Park.

WESTERN BLUEBERRY (Vaccinium occidentale)

The western blueberry is the next largest in size, as to both bushes and berries. The waxlike flowers and blue berries are in small clusters of two to four. The corolla is

only four-lobed, while flowers in the others have five. The ripe blueberries are delicious and have a bloom like plums.

WINGED-STEM BLUEBERRY
(Vaccinium membranaceum)

Vaccinium membranaceum has the largest bushes and berries. The shrubs are from one to three feet high. Like the western blueberry it grows in little patches here and there among the timber of the Montane Zone, but seldom covers large areas exclusively. The stems of new wood are sharply angled with a protruding membrane which accounts for its name. The purple-black fruit is very fine for table use or for canning. The flowers and fruit grow singly which make it easy to distinguish.

All huckleberries have a delightful odor. This alone will enable one to find patches a quarter of a mile away if the wind is favorable. A freshly opened can of blueberries fills the house with an appetizing odor and blueberry muffins and pies are beyond description. Bears strip twigs, leaves, and fruit greedily, and grouse fattened on huckleberries have a flavor all their own.

CREEPING WINTERGREEN (Gaultheria humifusa)

This evergreen shrub is the smallest in Yellowstone Park. It trails along the ground in moist, shady places with its leaves flat on the ground and might be easily overlooked were it not for the scarlet berries of later summer and autumn. It makes depressed mats from one inch to several feet in diameter. The thick, evergreen leaves resemble wintergreen, but the odor and taste are very different. The red, white, or pink, urn-shaped flowers are hidden among the shining leaves. It is very abundant at Burning Mountain and at the Frying Pan. Its scientific specific name "humifusa" means stretched-on-the-ground. Fresh-bruised leaves cause reddening of the skin. It is used externally as a remedy for ulcers and internally for dropsy.

ELDERBERRIES (Sambucus)

The elderberries of Yellowstone Park do not have flat-topped flower clusters like their eastern relatives. The form is more like that of a bunch of grapes.

THE RED ELDERBERRY (Sambucus pubens) has pubescent stems and leaves. THE BLACK ELDERBERRY (Sambucus microbotrys) is smooth. They are not abundant but are scattered here and there in the rich loam of mountain slopes climbing to 8,500 feet. The ripe fruit is wholesome, but not particularly delicious unless made into pies or sauce. Both have an indescribable wild flavor which must be tasted to be appreciated. Birds use the most of them. Both flowers and berries are recognized in the practice of medicine.

KINNIKINNICK (Arctostaphylos uva-ursi)

Kinnikinnick is a trailing, evergreen shrub, with leathery, spatulate leaves which have a notch at the apex. The large, dry, insipid, red berries are much sought by deer and grouse. They make large mats on dry hillsides about Golden Gate. One must look among the leaves to find the waxy, pink or white flowers for they are not so conspicuous as the berries. It is abundant throughout the lodgepole areas. The Indians used to smoke the dry leaves.

TWIN-FLOWER (Linnæa borealis)

Twin-flower is a delicate, trailing shrub with rounded-oval crenate leaves. At the leaf nodes it sends up thread-like stems two or three inches high. These fork at the top, each bearing a nodding white-to-purple bell. It trails over mossy rocks in deep-shaded ravines in the lodgepole pine areas. Twin-flower is abundant at Tower Falls but should never be picked as it is rare and easily destroyed. Its grace and beauty appeal to every lover of wild life.

SNOWBERRY (Symphoricarpos)

The snowberries receive their name for the snow-white berries of later August and September. They are low, branch-

ing shrubs from one to three feet high. The small, fragrant, white or rose-tinted flowers grow close to the stem in short spikes or singly in the axils of the leaves. There are three species in the Park.

(Symphoricarpos occidentalis)

Symphoricarpos occidentalis has bell-shaped flowers with the stamens protruding and thick leaves from one to two inches long. The flowers and fruit are usually in dense, short spikes near the top. It is sometimes called Wolfberry, a name which, so far as we know, has no connection with wolves. It is scattered about the Montane Zone, but grows much more abundantly in the Transition.

(Symphoricarpos racemosus)

Symphoricarpos racemosus also has bell-shaped flowers, but the stamens do not protrude and the leaves are thin and smaller than in the above. The flowers are not so congested at the apex. Among the lower branches the flowers are often in ones or twos. It is found about Mammoth and up to the slopes of Electric Peak. It likewise is much more abundant in the Transition.

(Symphoricarpos vaccinoides)

Symphoricarpos vaccinoides has a longer bell with rounded, oval leaves like a huckleberry and are somewhat velvety. It grows on the slopes of Electric Peak.

HONEYSUCKLE (Lonicera)

Our honeysuckles are not vines, but erect shrubs with fragrant flowers, in pairs. There are three kinds.

WILD HONEYSUCKLE (Lonicera cærulea)

Lonicera has pale leaves, yellow flowers about an inch long, and a sweetish, black berry. It grows from two to four feet high and has been collected at Mammoth, Gibbon River, Lone Star, The Falls, and at many other places throughout the Montane Zone.

UTAH HONEYSUCKLE (Lonicera utahensis)

Lonicera utahensis has bright, thin, green leaves, yellow flowers and globular red berries. The flowers are often tinted with purple. It is not so abundant as the last and does not grow so high. It is found about Mammoth.

TWIN BERRY (Lonicera involucrata)

Twin berry grows in swamps and shady, moist places about springs. It is an erect shrub three to six feet high, with sometimes two pairs of yellowish flowers in the axils of the ovate leaves. The sticky, glossy, black berries, as large as small gooseberries, are very striking. All honeysuckle berries are too bitter for man, but the wild life like them.

BEARD-TONGUE (Pentstemon fruticosus)

Beard-tongue is a low shrub less than a foot high which thrives under lodgepole pine. The red, violet, pink, or purple flowers are hood-shaped and about an inch long. The sterile stamen is much bearded which gives it the common name. There is a beautiful mat of it below the road at Golden Gate and at many places throughout the Montane Zone elsewhere.

(Macronema grindelioides)

Macronema grindelioides is a much-branched, low shrub about eight inches high, with sticky leaves and many scattered heads of yellow flowers. It would be difficult to separate from the many similar shrubs if it were not for the fact that it grows only on the upper slopes of high mountains. It is never abundant, but there are scattering shrubs on Sepulcher Mountain, Electric Peak, Mt. Washburn, and all of the high areas in the Hudsonian Zone. It belongs to the composite family, as do the sunflowers, and has many small flowers surrounded by a row of conspicuous yellow ligules about half an inch long. The heads are half an inch in diameter, and the number of ligules varies from six to twelve.

SAGES

KEY TO THE SAGES (Artemisia)

Plants usually freezing down in winter.

Inner flowers without seed;

Leaves green and glabrous, plant tall ..Artemisia aromatica
Leaves pubescent, plant short .....Artemisia pedatifida

Inner flowers with seed;

Woolly hairs among the flowers,
Heads small and numerous .....Artemisia frigida
Heads large and few .....Artemisia scopulorum

No woolly hairs among the flowers;

Leaves pinnate, smooth .....Artemisia subglabra

Leaves woolly on one or both sides;

Woolly on both sides,
Heads small and numerous ....Artemisia gnaphaloides
Heads larger and few .....Artemisia paucicephala

Woolly below only, green above,
Narrowly parted .....Artemisia discolor
With wider divisions .....Artemisia incompta

Plants shrubby, not freezing down in winter.

Leaves entire .....Artemisia cana
Leaves lobed or toothed,
Leaves lobed, heads few .....Artemisia arbuscula
Leaves toothed, heads many .....Artemisia tridentata
Leaves parted into narrow, linear divisions..Artemisia trifida

The thirteen species of sage found in Yellowstone Park are not prepossessing to the eastern visitor, but to the westerner who knows them well and has learned to like them they are as interesting as the larger forests. If this story should happen to fall into the hands of an old cow-puncher, he will remember how black the sage looked in March while there were still snow patches among the shrubs; how the sage-hens stalked about, picking the new, green leaves; how

pleasantly pungent the odor came up after a rain, or when the sun hit it in the morning as he stood drinking coffee from the old tin cup. When the "dogies" came down for water at noon, wasn't it fine to ride into the tall sage away from the flies and stretch out in the shade? When the mosquitoes were bad, sage smoke, sour and oily, would make them quit if anything would.

He remembers how the sage popped when the lariat caught a bush instead of a calf. Once it was the cinch that popped and he lit in the sage and cactus. Was there anything that would heat an iron, or burn the biscuits quicker? Riding by the log schoolhouse, he spurred the tired old "caballo" on the off side to make him buck till the schoolma'am came out. Then he threw the reins down and took a long walk among the fresh-bruised sage while he told her how lonesome he was.

Then there was the tragedy of bear and colt, cow and wolf, sheep and coyote, all acted out among the sage. Once when the sheep-herder got over on the cattle range, there came near being a more serious tragedy. He remembers how the lark-bunting soared up into the blue and slowly dropped into the sage, letting his music go like spray from a waterfall. There were meadowlarks and ground sparrows, cottontails and jacks, rattlesnakes and prairie dogs, owls and eagles, lizards and ants, all doing things among the sage. He cannot forget how he crept half a mile through the sage on his belly to get a shot at the buck antelope that made the fryingpan smell so good.

And wasn't sage an aggravating thing to picket the horse in? Before a can of tomatoes could be opened, the cayuse would be all wound up. When the baking powder got to griping, or if bad water had given him a touch of typhoid, it was sage tea that put him on his feet. He saw the Indians light their friction fires with the lint of the sage bark, and once when the icicles were hanging from the stirrups and the blizzard making forty miles an hour he thought of this and got a fire with a match stub. It wasn't five minutes till he could "roll one." Pretty comfortable around that sagebrush fire!

Then when the mess wagon got stuck, it was sage under the wheels that gave the tired horses a new start, and only yesterday when the car mired down in alkali it was an armful of sage that gave traction.

What is he doing now? Raising prunes in California, acting as chambermaid to a few cows in Minnesota, or pumping up the tires on a jitney anywhere.

Don't get sore, cowboy, and fumble around on your hip. There is nothing there now but a package of Bull Durham or a plug of Horseshoe. But you will remember that when you went back East on a visit, went broke, and went to work in a livery stable, it was a handful of sage in a stray bale of hay that made you jump your job and hit the blind baggage for Billings. Admit it, old timer, you are homesick as a dog! Homesick for sage!! Sage has gotten into your blood and into your mind. What would you give to straddle the old cayuse again and see the sage glide by?

Sage of the western plains
Bitter are thy leaves;
Sweet thy friendship.
Scraggy thy branches,
Gracious thy service.
Thou stemmest the tide of adversity
Winning where faint hearts lose
Fighting where odds are great.
Spirit of our West flows in thy veins,
Oh, Sage of western plains!

AROMATIC SAGE (Artemisia aromatica)

Aromatic sage does not have the sage odor, but smells like fennel. Between Mammoth and Gardiner, at Tower Falls, and the Lake, it is found on dry loose soil. It grows two feet high from a woody root.

SOFT SAGE (Artemisia frigida)

The foliage of soft sage is very delicate to the touch and a beautiful light gray in color. Ladies might find a sugges-

tion here for some new creations in dresses and bonnets. Its gray stems rise only one or two feet above the soil and usually freeze down in winter. It quickly takes possession of old gardens and plowed fields. Mammoth, Gardiner and Tower Falls are the leading locations. On the Blackfoot Reservation near Glacier Park the prairies are gray with it. The leaves are not so bitter as those of black sage. It climbs Mt. Washburn to 8,000 ft.

ROCK SAGE, OR ARCTIC SAGE
(Artemisia scopulorum)

The arctic sage grows only at high elevations. It is quite abundant on Mt. Washburn, along the Grasshopper Glacier trail, and at similar elevations throughout the Park. It is only four to eight inches high. Both the odor and the taste are very pungent and sage-like.

WOOLLY SAGE (Artemisia gnaphaloides)

Artemisia gnaphaloides is characterized by its silver-gray leaves and bushy clusters of flowers. It grows three feet high and usually freezes down in winter. Between Mammoth and Gardiner and at Tower Falls, it is quite abundant. The Indians used the seed for food.

(Artemisia paucicephala)

This is perhaps only a variety of the above. It has smaller heads and fewer flowers. Its range is the same as woolly sage.

TWO-COLORED SAGE (Artemisia discolor)

The narrowly divided leaves of this sage are so green above and so white below that it is very striking. The wormwood odor is so strong that it can be detected by the passing tourist without leaving the car. In bright sunshine the pungent smell can be detected for many rods. It is especially abundant in the Montane Zone among loose rocks and ascends into the Hudsonian. It has been collected from the higher

areas about Mammoth, up to the lower slopes of Mt. Washburn.

(Artemisia incompta)

This variety of the above has practically the same characters and range, but the leaf segments are much wider.

LITTLE TREE SAGE (Artemisia arbuscula)

Artemisia arbuscula grows along the Yellowstone River below the Lake. It is a stiff little tree one or two feet high and does not freeze down.

(Artemisia trifida)

Artemisia trifida is a shrub one or two feet high with very narrowly divided leaves. It is not abundant and has been collected only at Tower Falls.

BLACK SAGE—GARDINER

BLACK SAGE (Artemisia tridentata)

The leaves of black sage, as its name implies, have three teeth at the apex. It may be a sprawling shrub a few inches high in the upper Montane Zone or a small tree four inches in diameter and twelve feet high in the black loam about Gardiner. It forms about one half of the shrubby covering in Hayden Valley.

The common western name is black sage from the dark appearance of its stems in winter. It is an indication of fertile soil. Sagebrush land is good alfalfa land. The roots penetrate the soil from five to thirty feet. Many of our western plains would be wind-swept deserts without this deep-rooted shrub. Sage is to many birds, animals, and plants what the forest is to us. It offers food, shelter, and comfort. It is the most abundant western shrub and thrives on only a seven inch rainfall. It climbs to 7,000 ft. in the mountains. The Indians used sage tea for colds, headaches, worms, and to assist in childbirth.

GRAY SAGE (Artemisia cana)

Gray sage is the next most abundant in Yellowstone Park. It makes one third of the shrubby covering of Hayden valley, and can be distinguished by its lighter color at a great distance. The leaves are entire.

In mild September, when most of the flowers have gone to seed, it is rather surprising to see the shrubby sages in full bloom. As they are one of the earliest plants to put forth new leaves, the late blossoming is the more singular. The small, yellow, dusty flowers rise in wand-like spikes above the shrub. They withstand heavy frost, but freeze down in winter.

The scientific name is for a celebrated woman, Artemisia, who built for her husband, Mausoleus, one of the most beautiful tombs of the Orient. Our word mausoleum has this origin.

FACTORS CONTROLING GROWTH AND DEVELOPMENT

The trees of Yellowstone Park are all adapted to withstand heavy falls of snow. To understand their appearance in summer, one must imagine how they look in winter. The average precipitation for ten years is given below. The first column gives the total precipitation from both rain and snow in inches; the second snow only. They are for the northern side (the dryest part) only.

	Total precipitation	Snow
Dec.	2.0	12.2
Jan.	2.5	19.2
Feb.	2.0	12.2
Mar.	2.3	19.1
Apr.	1.3	8.7
May	1.8	2.5
June	1.7	1.0
July	1.2	Trace
Aug.	1.1	0.0
Sept.	1.0	1.9
Oct.	1.1	4.7
Nov.	1.6	13.2
Total	19.6 inches	94.7 inches

Snake River has the heaviest precipitation, 28 inches, and consequently the finest timber. Grand Canyon comes next with 26 inches. Upper Geyser Basin has 21 inches, and Riverside 20 inches.

To understand the tree life, one must consider many other factors, viz.—the humidity of the air, rapidity of evaporation, direction and velocity of the wind, frequency of killing frosts, length of growing season, rapidity of run off, heaving of frosts, length of time covered by snow, depredations of rodents, birds, and other animals, the physical constitution of the soil, the chemical constitution of the soil, the amount of light and the depredations of bacteria and fungi. One must not only consider the temperature of the air but the temperature of the soil. The struggle for existence between plants, and between plants and animals makes a most com-

Courtesy of James C. Witham

TREES IN WINTER

plicated drama which we are only beginning to understand. It is necessary to know the life history of each plant and animal before we can interpret this drama intelligently.

On the north side of Mt. Washburn and at many other places we find the bases of Spruce and Fir intact, while the top is badly mangled. Picture the base buried in snow and the tops cut by the wind-driven snow and ice and you have the solution.

What is the cause of parks, or open treeless areas within the forests? It may be too much or too little moisture. In digging down, a spring may be encountered or a dry sand-bank. Perhaps a colony of mice eat every seed that falls here, or it may be that other plants having a foothold are able to maintain it. Plants are fighters, as every one knows who has tried to keep a strawberry bed weeded the third season. Their struggle with each other and with their climatic environment is a very complicated drama. Thus no blanket generalizations can be made about the causes of parks. The reasons must be worked out in each individual case.

Rodents and birds have much to do with forest planting and forest destroying. It is hard to account for lodgepole pine forests springing up so evenly after a fire unless the seeds have been buried and scattered in part of them.

After the forest floor is well bedded with pine needles, most of the shrubs disappear. This is due not only to the lack of light and heat, but to the fact that pine needles inhibit the nitrification of ammonium sulphates so that the plants starve.

The trees of Yellowstone Park vary greatly in their response to light, heat, and moisture. Arranging them in order of their drowth resistance we have Juniper, Western Yellow Pine, Limber Pine, Mountain Maple, Douglas Fir, Lodgepole Pine, Engelmann Spruce, White-bark Pine, Alpine Fir, Aspen, Cottonwood, and Willows.

Arranged according to their light requirements we have,—Juniper needing most, then Limber Pine, Western Yellow Pine, Lodgepole Pine, Cottonwood, White-bark Pine, Aspen,

Douglas Fir, Mountain Maple, Willow, Engelmann Spruce, and Alpine Fir.

Arranged according to their ability to withstand fire, we have—Douglas Fir, Western Yellow Pine, White-bark Pine, Lodgepole Pine, Alpine Fir and Engelmann Spruce.

In withstanding smoke and smelter fumes, we have—Alpine Fir most resistant, then Douglas Fir, Lodgepole Pine, Engelmann Spruce, Juniper, and Limber Pine.

Lodgepole Pine covers approximately 75% of the forested area of the Park, Engelmann Spruce 10%, Douglas Fir 5%, Alpine Fir 5%, Aspen, Cottonwood and Willows 5%.

While there are many varying factors, in general the upper limit of the trees is determined by heat and the lower by moisture.

The prevalence of lodgepole pine in Yellowstone Park, points conclusively to the fact that it has been subject to continuous fires. As the forest matures, Engelmann spruce and Douglas fir will grow more abundant. Approximately 10% of the trees are less than fifty years old, 50% are between fifty and a hundred twenty years old, and 40% are older.

It is a singular fact that on the alpine peaks of the Park and the Beartooth Forest adjoining on the north, Engelmann spruce outnumbers all other trees with white-bark pine second.

In the Beartooth forest, lodgepole pine forms 45% of the forested area, limber pine 2%, white-bark pine 5%, Engelmann spruce 22%, Alpine fir (Abies lasiocarpa) 11%, and Douglas fir 12%. Timber line is at 9,300 ft. on north slopes and 9,800 ft. on south slopes. As Grasshopper Glacier is in this area, it seems proper to mention it here.

PETRIFIED FORESTS

If the little roadside pond at the base of Burning Mountain had been deeper, the group of trees standing in it would have been buried in the silicated mud and water. Minerals would gradually have replaced both bark and wood till the form was preserved in stone. Years later, erosion might reveal this petrified forest for thoughtful tourists to puzzle

over. Nearly every square mile of the northeast corner of Yellowstone Park contains petrified forests.

Those who have visited volcanic regions know, that beside burning lava there are deep layers of dust, ashes, and pumice. Heavy rains wash these into depressions. The wind drifts them as it does sand. Thus forests are buried as they stand without being destroyed.

Geologists tell us that Yellowstone Park was once a mile below its present level. Great volcanoes, of which Mt. Washburn was one of the most recent, by successive eruptions, gradually filled the great basin between the Absaroka and Gallatin Mountains. During this long period forests were destroyed and replaced, trees were buried and uncovered again by erosion. The volcanoes, however, worked faster than the rivers and the levels gradually rose. The forests mounted triumphantly on the new soils only to be destroyed or buried again.

These early forests were from the south and resembled the trees of our southern Appalachians. There were ten species of oaks, four of poplar, four willows, four elms, two sycamores, eight figs, four magnolias, six laurels, three acasias, beside sequoia, ash, viburnum, walnut, hickory, myrica, alder, chestnut, rhus, maple, basswood, cornus and many others. The larger part of the buried trunks are pine. It is estimated that fifteen successive forests were entombed on Amethyst Mountain.

The light colored lavas (acid series) are the older with seventy-nine species of plant life, the intermediate lavas have thirty species, the dark colored lavas (basic) have seventy species. Twenty-three species are common to two or more beds and eight common to all three. From this we have an inkling of the vast stretch of time in which these beds were laid. The deposits of silica at the Castle Geyser are estimated at one thirtieth of an inch a year, making this cone about twenty-five thousand years old. Its beginning takes us back to the latter days of the ice age. During this time the drainage of the Park changed profoundly. We know that the Yellowstone formerly emptied into the Snake River.

While the ice age is remote, it is but yesterday as compared with Cretaceous times when the willows and poplars had their beginning. Their imprint in the yellow stones of the great river below Livingston is evidence indisputable that they were there. The soil which buried them is from volcanoes and mountains long since eroded away and the distant ocean has advanced and retreated several times since their leaves were imbedded in its shallow waters.

The pines are probably older than the willows, birches, and cottonwoods. Emerson has them say—

"Old as Jove
Old as love
Who of me
Tells the pedigree?
Only the mountains old,
Only the waters cold,
Only the moon and stars,
My coevals are.
Ere the first fowl sung
My reclining boughs among—
Ere the lion roared,
Ere the eagle soared
Light and heat
Land and sea
Spake unto the oldest tree."

Man is but a recent incident in the life history of the trees. They have seen him come, witnessed his struggle with the elements and wild beasts, and they will likely see him go. Whether his departure will be due to an unfriendly climate, to the ravages of bacteria, or to the failure to adjust his individual and his social passions, who can say?

The duration of any organism depends on its ability to adapt itself to environment.

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These pages are only a preliminary survey. Much of the Snake River country and the higher mountain areas have not been explored. All students of this most interesting region must confess with the Immortal Bard,—"A *little* in the book of Nature I can read."

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